International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 11 No. 4s, 2025
https://www.theaspd.com/ijes.php

Study Of The Specifications Of Some Chemical Standards For The Water Of The Baiji Unified Water Project

[1]**Baraa Dawood Mohammed Hamad, 2 Assist.Prof.Dr. Ali Muayad Sultan**
Biology Science Dept.College of Education for Girls, Tikrit University, Iraq
Corresponding Author E-mail: baraa.dawood343@st.tu.edu.iq
Second Author E-mail:alimusu82@tu.edu.iq

Abstract
This study aimed to demonstrate the effect of chemical properties on water in Baiji district, which includes determining the quality of this water. The study began in September 2024 and continued until February 2025. The study included some chemical properties such as (salinity, pH, dissolved oxygen, total alkalinity, total hardness, calcium hardness, magnesium hardness, and biological oxygen demand, in addition to some ions such as chloride ion, sulfate ion, nitrate, nitrite, and phosphate). The results were compared based on international and Iraqi standards. The results of this study showed that the highest value of salinity was 285 g/L, and the lowest value was (230) g/L. As for the pH, the lowest value was 6.4 and the highest value was 8, and its rates ranged between (7.23 -7.44), and its values ranged between weak acidity and weak basicity, which is within the Iraqi water specifications. As for the dissolved oxygen, its rates ranged between (7.478 - 8.685) mg/L, while the biological oxygen requirement had its highest value of 168 mg/L and its lowest value was zero, while the total alkalinity ranged between (90 - 188) mg/L, and the total hardness ranged between (275.7-302.3) mg/L, and the calcium rates ranged between (61.17 - 64) mg/L, and the magnesium had its lowest value of 14 mg/L and its highest value of 77 mg/L, and the sulfate rates ranged between (70.7 - 72.5) mg/L, and the chloride ranged between (17 -36) mg/L, while the nitrate had a lower value of 2.598 micrograms/L and the highest value was 8.116 micrograms/L, and the nitrite had a lower value of 0.035 micrograms/L and the highest value was 0.759 micrograms/L, while the effective phosphates had rates ranging from (1.537 - 2.010) micrograms/L.

Keywords: *Baiji Water Station, Chemical Properties of Drinking Water, Iraqi Standard Specifications No. 417 for drinking water (2001)*

INTRODUCTION:

Water is of great importance to living organisms, no less important than air. It is an important source for drinking and other daily uses. Rivers are an important source of water used by humans, but human activity and residential areas have contributed to the pollution of its water (Awad and Shahata,(2017), Water has distinct chemical properties that make it important in its uses for various purposes, and the organisms in it show a high sensitivity to the changes that occur in its chemical properties. These factors affect...The nature of life for the organisms that live in it (Melo & Haszar, 2000),Aquatic organisms such as fish show high sensitivity to changes in these characteristics of the environment in which they live (Mahmoud et al.,2018)Anything that reduces the quality of water makes it unsuitable and negatively affects living organisms, including fish. (Cunningham et al., 2007), there are millions of people around the world who are at risk of consuming contaminated water, as the aquatic environment has not been spared from the negative impact of humans on it due to their agricultural and industrial activities that have exacerbated the problem (Al-Hamdany et al., 2022; Rukavishnikov et al., 2024; Hassan and Ali, 2022), as providing drinking water suitable for human consumption is a vital measure for human health (Li et al., 2023), as administrations and institutions around the world work to monitor the quality of drinking water periodically to prevent the spread of epidemics, diseases and infections transmitted among consumers (Al-Barzegar et al., 2023; Shanona et al., 2020; Yasmeen and Yasmeen, 2023).Water often contains elements and compounds that vary in concentration and are beneficial to living organisms. However, increased concentrations of these elements cause water pollution, which prevents its use in various aspects of life (Al-Kamar, 2018). Polluted water is one of the causes of the spread of diseases and the high number of deaths, as approximately25 million people die annually due to contaminated water, according to reports from the World Health Organization (Al-Safawi et al., 2018). The Tigris River is the main source of drinking water in the city of Baiji, and the potential for changes in chemical properties and the need to monitor water quality before it enters the Baiji desalination plant. Therefore, this study was chosen to achieve a healthy and clean environment in line with what other developed countries are striving for.

Materials and method of work:

- **Sample collectionSamples collection**

Water samples were collected from five study sites, one sample per month, during the study period, which extended from September 1, 2024, to February 1, 2025. The samples were collected to study some chemical properties of the water. They were collected in plastic bottles.(Polyethylene) size (2.25) liters after washing well with water,

To determine the amount of dissolved oxygen (DO) and biological oxygen demand (BOD) were collected in opaque Winkler bottles of (250) ml capacity with (BOD) and transparent bottles for measuring (DO) were collected in sterile plastic bottles of (50) ml capacity.

The plastic bottles were tightly closed and the necessary information was recorded on each bottle, then they were transferred to a refrigerator at a temperature of4C° for chemical analysis.

- **Chemical tests:**
- **pHpH**

The pH value was recorded using a type (pH meter Lovibond Germany) after calibrating it with buffer solution pH (4,7,9) at the beginning of each measurement.

- **Dissolved oxygen measurementDissolved Oxygen**

According to the method mentioned in (2005(APHA) Dissolved oxygen was measured using a device (Oxygen meter lovibond) made in Germany in the laboratory. The device was calibrated at each reading by calibrating it with the amount of oxygen in the atmosphere. The device reads (20.9), which is the amount of oxygen in the atmosphere.

The reading is then converted to mg/L and the oxygen in the water is measured.

- **biological oxygen requirementBiological Oxygen BOD**

The biological oxygen requirement was calculated using the method used to measure dissolved oxygen. The opaque Wakar bottles were placed for five days at a temperature of (25) degrees Celsius inside a water bath.Water Bath then determines the dissolved oxygen (DOS) and the difference between the initial dissolved oxygen (DO), represented by the BOD value in mg/L (APHA 2005).

$$-DO_5 = DO_0 \ BOD_5$$

- **Total base Total Alkalinity**

The base was determined according to the method described by ((1984) Welch expressed the results in mg/L. 50 ml of the sample was taken and 3 drops of methyl orange indicator were added to it, resulting in a yellow color. It was sensitized with 0.02N sulfuric acid until the color changed, and the average of two readings was taken. The basicity of calcium carbonate was calculated according to the equation:

$$Total\ Alkalinity\ (mg¿) = \frac{VH\,2SO\,4 \times NH\,2SO\,4 \times 1000 \times M.W\ as\ CaCo\,3}{Vsample}$$

- **Sulfate measurement Sulphate SO4**

Sulfate ions were determined by the methodTurbidity Method: A volume of 100 ml was taken, then 5 ml of the conditioned solution was added and mechanical shaking was carried out at a constant speed using a magnetic stirrer. Then barium chloride crystals were added while mechanical shaking continued for another minute. After that, the concentrations were read and calculations were carried out by comparing them with the standard curve, and the results were expressed in mg/L (Abawi and Hassan, 1990).

- **Chloride**

Chloride was measured according to the American Society for Testing and Methods (ASTM).(1984) ASTM water tests were carried out by taking 50 ml of sample water and adding a few drops of potassium dichromate to it. Then, the water was titrated with a standard silver nitrate solution at a concentration of 0.025 N until the colour changed from yellow to reddish brown, and it was expressed in mg/L.

- **Nitrate measurement Nitrate (NO3)**

Nitrates were measured using the indole method at a wavelength of394 nm and is expressed in micrograms per liter.

- **Phosphate Ort hophosphate**

The phosphate value was recorded based on the method published by (Abawi and Hassan:1990) Phosphate content of the samples was determined using a spectrophotometer CE 1011CECIL at a wavelength of 690 nm. The results were expressed in terms of micrograms of phosphorus-phosphate atoms/L. (10 g) ml of the sample was placed in a beaker and a solution of 2 ml of sulfuric acid with (40) ml of deionized water was added to it. The reaction mixture was then cooled, (2) ml of aluminum molybdate solution was added and the solution was diluted to 100. 5-7 ml drops of stannous chloride solution were added and heated until the dissolution process was complete. A blue color was formed, the intensity of which depended on the phosphorus concentration in it. The solution was left for (10-15) minutes, after which the absorbance was measured at a wavelength of (690 nm).By preparing the standard solutions, the phosphate concentration was found from the equation for each curve. The results were expressed in micrograms of phosphorus-phosphate atoms/liter. (Abawi and Hussein,1990).

1. Results & Discussion

- **Hydrogen base (pH)**

The results of the current study shown in Table (1) showed that the lowest value was in the first station in October, which was (6.4) While the highest pH value in the water was (8) at the fourth and fifth stations in January, as shown, the pH values were close and within the basic level, and this is a distinctive feature of Iraqi water. The reason for the stability of the pH in this narrow range of low basicity is the presence of bicarbonate ions in the Tigris River water, and due to the lack of addition of alum and chlorine, the pH values did not reach less than (77). The process of adding chlorine leads to the formation of hypochlorous acid (HOCl) and hydrochloric acid (HCl), while adding alum leads to the formation of carbon dioxide gas, which reacts with water to form weak carbonic acid, which leads to a reduction in pH (Al-Lahibi, 2021).The results of this study were consistent with the results of the study by Al-Naimi (2017) on the Tigris River, and they were (8.4-7.7) and (6.8-8.0) respectively. From this it is clear that the Tigris River water is suitable for filtration plants because it falls within the permissible range for drinking water (8.5-6.5)The results of the statistical analysis using analysis of variance showed that there were significant differences between the pH values at the stations, and also significant differences between the months at a significant level.) 0.05 ≤ P (and between Pearson's correlation coefficient, as there is a positive correlation between the pH of salts, electrical conductivity and temperature at a significant level r=0.513, 0.361, 0.376)), as the pH results in the current study were within the permissible limits of the Iraqi standard specifications 417 for drinking water (2001) and the World Health Organization (WHO, 2004), which ranged between (8.5-6.5).

Table (1) Monthly and site-specific changes in pH at the stations during the study.

Average months	Fifth Station	The fourth station	The third station	Second station	First station	Stations The months
7.34 bc	7.61	7.11	7.69	7.35	6.91	September
7.00 c	7.25	6.98	6.98	7.21	6.4	October
7.10 c	6.62	7.03	6.87	6.98	6.87	November
7.50 b	7.73	7.26	7.6	7.5	7.4	December
7.84 a	8	8	7.4	7.9	7.9	January
7.42 b	7.1	7.1	7.3	7.7	7.9	February
	7.39 a	7:30 A	7.31 a	7.44 a	7.23 a	Average station type

- **Dissolved oxygen (Dissolved Oxygen (DO)**

The table shows (2) Dissolved oxygen values where the lowest value was (**5.32**) mg/L at the fifth station during the month of October, while the highest value was at the third station in the month of November.(**12.97**) mg/L, as the results of this study were close to the results of the study (Al-Douri, 2019), as the dissolved oxygen values reached (9.1-4.9) mg/L, and close to the results of (Al-Bayati, 2023) and (Al-Sabaawi, 2023), (11.2-4.4) and (6.1-10.6) mg/L, respectively, while the results of the study (Saleh, 2020) for the dissolved oxygen values were between (1.7-4.4) mg/L, and were less than the results reached by the researchers Al-Nasiri (2019) and Al-Dulaimi (2021), as the studies recorded the dissolved oxygen values (7.4-14.5-5.8, 12.5) mg/L, and among the sources of

International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 11 No. 4s, 2025
https://www.theaspd.com/ijes.php

dissolved oxygen in water is the atmosphere, which is in contact with the water surface, which is considered the main source of oxygen, and the speed of its penetration into the water depends on the difference in atmospheric pressure and speed Flow, water body area and also phytoplankton activity (Ayanshola et al, 2019) are generallyThe efficiency of the water produced from the liquefaction plant is considered good and matches the dissolved oxygen values proposed for drinking water within the limits of Iraqi specifications. 417 for drinking water (2001) and the global limit of >5 mg/L (WHO, 2004).

Table (2) Monthly and site-specific changes in dissolved oxygen (mg/L) at the studied stations

Average months	Fifth Station	The fourth station	The third station	Second station	First station	Stations The months
6.482 CDs	6.62	6.76	6.54	6.33	6.16	September
5.722 d	5.32	5.8	5.76	5.88	5.85	October
10.130 a	9.47	8.24	12.97	9.26	10.71	November
8.846 b	8.36	9.1	10.41	9.42	6.94	December
8.580 b	8.7	9	7.8	8.4	9	January
7.732 bc	7.6	8,365	8.63	7.86	6.205	February
	7.678 b	7,878 b	8.685 a	7,858 b	7,478 b	Average station type

- **Biological Oxygen Demand (BOD)**

The results are shown in the table (3) The lowest value was (0) mg/L in the first station in September, and in the first station in October, and the second, fourth and fifth stations in December, and the fifth station in February, while the highest value of the biological oxygen requirement in the studied water was (19) mg/L in the third station in September, as the results of this study were close to what was stated by (Al-Hadith, 2023) as the values ranged between (10-16) mg/L and higher than the results of (Al-Nasiri, 2019) as they recorded values ranging between (3.3-0) mg/L. The reason for the increase in the values of theBOD is due to the arrival of some human pollutants to the water and the occurrence of an oxidation process for organic materials (Negi et al., 2020), as the increase in the values of biological oxygen demand affects and negatively reflects on the amount of dissolved oxygen (Awad et al., 2020). The reasons for its decline in general are continuous mixing, good ventilation, low temperature, and self-purification of the water surface (Al-Sarraj (2019), as the activity and effectiveness of microorganisms results in an increase in the decomposition process of organic materials and thus the depletion of dissolved oxygen in the water).Ibo et al, 2020), and it was shown through statistical analysis using analysis of variance that there were no significant differences in concentrations between the five studied stations, while significant differences were recorded between the study months at a significant level ($P \leq 0.05$). Pearson's correlation coefficient also indicated the presence of a positive correlation between the biological oxygen demand, salts and turbidity at a significant level ($r = 0.580, 0.155$). Most of the rates of biological oxygen demand were consistent with the values of the biological oxygen demand for drinking water within the standard specifications of the World Health Organization (WHO, 2004), which amounted to < 3 mg/L.

table3) Monthly and local changes in the biological oxygen demand (mg/L) at the studied stations.

Average months	Fifth Station	The fourth station	The third station	Second station	First station	Stations The most famous
17.5 a	15	16	19	20	0	September
11.6 b	33	2	14	9	0	October
10.6 b	6	17	7	10	13	November
1.20 d	0	0	4	0	2	December
1.04 d	0.8	0.7	0.9	0.9	1.9	January
5.0 c	0	7	13	1	4	February
	9.133 b	11.16 a	9.65 b	6,817 c	3,483 d	Average station type

- **Total Alkalinity (TH)**

Table (4) shows different values of total alkalinity, where the lowest value of alkalinity was (90) mg/L in the first and third stations in October, and the highest value of alkalinity in the water was (188) mg/L in the first station in January, as alkalinity represents the amount of negative ions present in the water that work to resist hydrogen ions, so it expresses the ability of the water to neutralize acids or what is called ANC. Al-Fatlawi (2007) indicated that the reason for the decrease in the alkalinity values in the water during the dry season may be due to the depletion of bicarbonates due to an increase in the rate of photosynthesis resulting from an increase in the number of algae. The lowest value recorded in the current study (106) mg/L, which is less than the value recorded by (Al-Hamdani, 2013) which is (140) mg/L and higher than the lowest value recorded by (Al-Duri, 2024) which recorded (40) mg/L, and Al-Dulaimi also (2021) which recorded (62) mg/L, and the reason may be due to the effect of alkalinity on the filtration process due to the addition of alum and chlorine which works to decompose bicarbonates and release carbon dioxide gas (Gebbie, 2000), as the results of the study showed that the Tigris River water was alkaline, and this is what previous studies indicated that alkalinity is a common characteristic of Iraqi water and is consistent with other studies (Al-Fatlawi, 2007 and Al-Moussawi and his group, 2012 and Al-Azzawi, 2010), as the results of the statistical analysis of alkalinity using the analysis of variance test showed the presence of significant temporal differences within the study months at a significant level ($P \leq 0.05$) with the presence of significant spatial differences within the study stations and between the Pearson correlation coefficient indicating the presence of a positive correlation with turbidity at a significant level $r=0.651$), as the results were identical to the current study in most of its rates for the total alkalinity values proposed for drinking water within the standard and international specifications (WHO, 2004; US-EPA, 2002) amounting to 250 mg/L.

Table (4) Monthly and site-specific changes in total alkalinity (mg/L) at the studied stations.

Average months	Fifth Station	The fourth station	The third station	Second station	First stop	Stations The months
144 b	130	130	150	152	158	September
116 c	140	150	90	110	90	October
146 b	150	140	140	160	140	November
146 b	160	140	140	140	150	December
161 a	146	140	166	166	188	January
148 b	140	148	160	150	142	February
	144.3 a	141.3 a	141.0 a	146.3 a	144.7 A	Average station type

- **sulfates** Sulphates (SO4-2)

The results of the current study showed variations in sulfate concentrations as shown in Table No. (5), where the lowest valueFor sulfates(**59**)mg/L in September for the first and fourth stations and in October for the second and third stations, and the highest value was recordedFor sulfates (90) mg/liter in February in the first and second stations, and the reason for the high sulfate ion values may be the presence of sulfur springs near the Tigris River in Baiji. In general, the current recorded results match the specifications of Iraqi drinking water, which is less than (250) mg/liter.The results of (Al-Hibeeb,2021) between 27)-59) mg/L, and (Furtum, 2018) mentioned in his study that the sulfate values ranged between (130-37.7)mg/LThe results of what Al-Zuhairi (2024) reached were less than the results of the current study, as he stated that the values of sulfates in the Tigris River ranged between (39-60) mg/liter.And less than what he reached (Al-Majmai2024) which ranged between (32.6-189) mg/L, as this variation in sulfate concentrations in the stations may be due to the decomposition of organic materials in the soil in those areas, as this ion has the ability to reach the water source when using agricultural fertilizers, as well as the water discharged from domestic sewage, which usually contains this ion (Varol et al. 2011,) that sulfates do not cause harm or problems at concentrations below 250 mg/L, and therefore the current study stations do not need sulfate removal units at the present time, as the sulfate concentrations in the current study were below the permissible limit set by the US Environmental Protection Agency (US-EPA, 2002), the Iraqi Standard Specifications No. (417) for drinking water (2001), and the World Health Organization (WHO, 2004), which set a level of 250 mg/L as an upper limit.

Table (5) Monthly and locational changes in sulfate values (mg/L) at stations during the study.

Average months	Fifth Station	The fourth station	The third station	Second station	First station	Stations The months
60.2 d	63	59	60	60	59	September

International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 11 No. 4s, 2025
https://www.theaspd.com/ijes.php

60.2 d	60	62	59	59	61	October
78.0 b	78	77	76	79	80	November
73.2 c	71	72	73	77	73	December
71.8 c	73	73	71	70	72	January
86.6 a	79	87	87	90	90	February
	70.7 a	71.7 a	71.0 a	72.5 a	72.5 a	Average station type

- **Chloride (Cl—)**

The results showed that the lowest value was (17) mg/L at the fifth station in January, and the highest value of chloride ion in the water was (36) mg/L at the second station in September, as shown in Table (6), andThese results were close in terms of the minimum values with the results of each study.From (Al-Majmai, 2024) and (Al-Bayati,2023)And (2020 AL-Sarraj,) where the values ranged)17)(18)(11)mg/L respectivelyand inconsistent with the results reached by (Sultan,2019) where it was limited to (30.0-60.0) mg/L, and (Al-Laheebi, 2021) who recorded in his study (55-28) mg/L during the study period., The results of the current study showed an increase in chloride values in September as a result of the rise in temperature, which increases the evaporation process of water and thus increases the concentrations of ions, and a decrease in values in the winter. The reason for this is attributed to the rise in water levels due to rain, which leads to the dilution of river water (Al-Rubaie, 2007). The results of the current study showed that they were less than the results recorded by (Al-Kubaisi et al.,2001) and (Al-Lami et al., 2005) as they recorded (183-73.4, 180-80) mg/L respectively, and accordingly the results of the current study appeared within the permitted and suggested chloride concentrations for drinking water within the Iraqi and international standard specifications (WHO, 2004 US-EPA, 2002) proposed for drinking water which amount to 250 mg/L.

Table (6) Monthly and locational changes in chloride ion (mg/L) at stations during the study

Average months	Fifth Station	The fourth station	The third station	Second station	First station	Stations The months
29.4 ab	25	29	23	36	34	September
26.4 b	27	28	26	22	29	October
27.0 b	28	27	27	26	27	November
20.6 c	22	20	20	21	20	December
23.2 c	17	19	26	26	28	January

32.0 a	28	34	34	34	30	February
	24.5 a	26.2 a	26.0 a	27.5 a	28.0 a	Average station type

- **Nitrates (NO3)**

The results of the current study shown in Table (7) showed that the lowest value was (**2.598**)mg/L at the fourth station of January, while the highest value of nitrates (**8.116**)mg/L in the first station for the month of October, and the results of the current study did not agree with the results of the study (Al-Dulaimi, 2021), as his study recorded values ranging between (1.26-0.35) Milligram/liter, and the values of the current study were higher than what was reached by (Al-Hadith, 2023), whose study recorded values ranging from (1.8-0.9) mg/liter, and the study (Al-Duri, 2019) recorded values ranging from (24.75-1.06) mg/L, as the results of the current study showed higher concentrations than what was reached by (Al-Majmai, 2022), as these values ranged between (2.30-6.04) mg/L, and also the results of the study (Al-Hadidi, 2018), in which the values of the nitrate ion ranged between (0.09-6.27) mg/L, and less than what was obtained by (Al-Janabi, 2020), in which the values of the nitrate ion were recorded between (1.3-36.7) mg/L. These results came in accordance with the standard specifications No. (547) for drinking water, which amount to 50 mg/L as a maximum.

Table (7) Monthly and site changes in nitrates (mg/L) for stations during the study

Average months	Fifth Station	The fourth station	The third station	Second station	First station	Stations The months
6.685 a	6.622	6,019	7,045	5.821	7.92	September
7.018 a	6,461	7,066	7,096	6.35	8.116	October
6.117 b	5,958	5,469	6,316	5.36	7,484	November
5.493 c	5.124	4,211	5,747	5,949	6,436	December
2.737 e	2,599	2.598	2.783	2.783	2.921	January
4.638 d	4.232	4.726	5.296	4.075	4.862	February
	5.166 B	5,015 b	5,714 a	5,056 b	6,290 a	Average sample type

- **Effective phosphates ((PO4 Reactive phosphate**

The values of the current study shown in Table (8) showed that the lowest value was (**0.8**) mg/L at the fourth station in January, while the highest concentration of phosphate in the water(**2.598**)Milligrams per liter in the third station during the month of September, as the values of this study were close to the values of the results of the study (Al-Dulaimi,2021) whose study recorded values ranging between (3.6 -0.02) Milligram/liter, as it came close to the results of what

Al-Hadith (2023) reached, as his study recorded values ranging between (2.92-1.39) mg/L, while the highest value recorded in the current study was less than what was mentioned by (Al-Zuhairi, 2024), as his studies recorded(0.19-0.011) mg/L. The results of the statistical analysis showed that the phosphate values did not conform to the standard specifications No. 417 for drinking water (2001), which amounted to 0.4 mg/L.

Table (8) Monthly and site changes in phosphate (mg/L) in the studied stations

Average months	Fifth Station	The fourth station	The third station	Second station	First station	Stations The months
1.998 a	2.437	2,238	2.598	0.933	1.784	September
1.915 a	1.516	2.13	1.656	1.9	2.374	October
1.881 a	1.599	1.821	1,913	1.815	2.26	November
1.708 ab	1,407	2,021	1.798	1.415	1.899	December
1.460 b	1.1	0.8	1.7	1.7	2	January
1.712 ab	1.162	1.861	2.395	1.54	1.602	February
	1.537 B	1.812 a	2,010 a	1,550 b	1.986 a	Average sample type

CONCLUSIONS

All chemical tests were within the permissible limits set by Iraqi drinking water specifications, with the exception of phosphate levels, which were higher than the permissible limits. Awareness campaigns should be conducted to highlight the reasons for the increased phosphate concentrations. Farmers in areas close to the river should also be instructed to limit the use of chemical fertilizers, which increase water pollution.

REFERENCES

- Awad, Mohamed Hassan and Shehata, Hassan Ahmed (2017). Environment and Pollution Problems. Al-Azhar University.
- **Al-Mahdawi, Mahmoud Mustafa and others (2018)**Estimation of some chemical and physical properties using forced vortex water treatment unit compared to their concentration in water produced by traditional potable water projects in Baghdad. Iraqi Journal. Volume 10, Issue (1).
- Al-Kamar, Baraa Majid Khalif (2018). Physical, chemical and bacteriological properties of groundwater in the holy Karbala Governorate. Master's thesis, College of Science - Tikrit University
- Al-Safawi, Abdulaziz Younis Tali'a, and Al-Assaf, Azhar Younis Reda (2018) Qualitative assessment of Tigris River water using water quality factors (WQI) for drinking purposes in Nineveh Governorate, the Ninth Periodic Scientific Conference, Dams and Water Resources Research Center, November 28-29, University of Mosul.
-

- Al-Bayati, Aya Katea Jihad Al-Bayati (2023) A physical, chemical and bacteriological study of the water of the unified Kifri project - Salah al-Din Governorate, Master's thesis, Tikrit University, College of Education for Girls, Department of Life Sciences.
- **Central Agency for Standardization and Quality Control ((1996.** Iraqi Standard Specifications for Drinking Water. Iraqi Specifications No.417.
- **Al-Hadidi, Amina Faris Farhan (2018).** Evaluation of the water quality of the Tigris River in the area between Mosul Dam and Qayyarah Dam for different uses, Master's Thesis, College of Environmental Sciences and Technologies, University of Mosul.
- **Al-Hamdani, Salma Khaled Yassin (2013)** A study of seasonal variables of diatomaceous algae present in the Tigris River in Tikrit city. Master's thesis, Tikrit University / College of Education for Girls / Department of Life Sciences..
- Al-Douri, Dhamiya Khalaf Yassin (2019) A biological, chemical and physical study to evaluate the efficiency of the southern drinking water purification plant in Al-Dour District, Master's Thesis, Tikrit University / College of Education for Girls / Department of Life Sciences.
- **Sultan, Fatima Moaz Hamed (2019)** Evaluation of the efficiency of the old left liquefaction station and identification of pollution sources in the transmission lines, published master's thesis, College of Environmental Sciences and Technologies, University of Mosul.
- Salman Khalaf Al-Sabaawi (2023). Evaluation of the efficiency of the drinking water treatment plant in Makhmur district in Nineveh Governorate - Master's Thesis - Life Sciences - College of Science - University of Mosul.
- **Saleh, Ahmed Rashid Ahmed (2020)** Evaluation of the physical and chemical properties and determination of the algal content of the water of the Hawija irrigation project in Kirkuk Governorate, Master's thesis, College of Science, Tikrit University, Life Sciences.
- **Abawi, Suad Abdul, and Hussein, Muhammad Suleiman (1990).** Environmental Engineering Science. Water Testing. Dar Al-Hikma for Printing and Publishing, University of Mosul, Mosul, Iraq.
- **Al-Fatlawi, Ya'rab Faleh Khalaf (2007**). Evaluation of the efficiency of irrigation projects in Baghdad. PhD thesis, College of Science, University of Baghdad..
- **Furtum, Zuhair Farouk Ahmed (2018).** Evaluation of the efficiency of four drinking water treatment plants in Salah al-Din Governorate, Master's thesis, College of Science, Tikrit University.
- **Al-Lahibi,Amjad Abdul Latif Ahmed (2021)** Physical, chemical and bacteriological evaluation of drinking water prepared by purification units spread in Tikrit city and its suburbs, Master's thesis, College of Science, Tikrit University.
- Mahmoud, Iman Shaker, Abdul Jabbar, Riyadh Abbas and Kharnob, Hussein Hassan (2018). Physical and chemical properties of Tigris River water in Salah al-Din Governorate, Iraq. Tikrit University Journal of Agricultural Sciences, 18(2): 120-128.
- **Al-Nasiri, Mirage Raouf Daoud (2019)** Evaluation of the efficiency of the Tikrit Unified Water Treatment Plant in purifying drinking water and determining its suitability for consumption. Master's thesis, College of Science, Tikrit University.
- **Al-Naimi,** Marwa Mohammed Mahmoud (2017). A comparative study of the operation of three major drinking water treatment plants in Nineveh Governorate. Master's thesis, College of Science, Department of Life Sciences, University of Mosul..
- Al-Dulaimi, Yazan Yassin Jabbar Matar (2021) Hydrological characteristics of Lake Habbaniyah and its environmental impacts, Master's thesis, College of Arts, University of Anbar.

- Lina Adnan Al-Hadith (2023), Seasonal physical, chemical and biological changes in the waters of the Tigris River passing through the city of Tikrit - Salah Al-Din, Master's thesis, College of Pure Sciences - Tikrit University.
- Al-Sarraj, Iman Sami Yassin (2013) A study of the pollution of the Tigris River with various wastes within the city of Mosul and its impact on a number of local fish. PhD thesis - College of Science - University of Mosul.
- **Al-Moussawi, Iman Mahdi; Hatem, Qais and Ibrahim, Ayoub Abbas (2012).** Study of some physical and chemical properties of selected drinking water stations in Babylon Governorate,journal of Babylon university/engineering sciences no.(1)/vol. (20):2012.
- Al-Azzawi, Israa Salman Dales (2010). Environmental and bacteriological study of the Al-Alam irrigation project in Salah al-Din Governorate, Master's thesis. College of Science - Tikrit University.
- Al-Zuhairi, Qamar Muhammad Hussein Karko Al-Zuhairi (2024), Evaluation of the qualitative characteristics of tap water in specific neighborhoods of Mosul city / left side, Master's thesis, Environmental Sciences - University of Mosul.
- Al-Majmai, Sarah Hashem Sahi, and Al-Jubouri, Yassin Hussein Awad (2022). A study of some physical, chemical and bacteriological characteristics of water samples from Al-Ishaqi Water Supply Station / Salah Al-Din Governorate, Master's thesis in Life Sciences, College of Education for Girls, Tikrit University.
- **Al-Majmai, Ghazi Shams Saleh (2022)** Evaluation of some physical, chemical and bacteriological properties of Al-Ishaqi River in Salah Al-Din Governorate, Master's Thesis, College of Science, Tikrit University.
- Blessed be Madin Abdul Majeed (2024), Evaluation of the qualitative characteristics and efficiency of Al-Ishaqi liquefaction plant - Salah Al-Din Governorate, College of Education for Girls - Tikrit University.
- **Al-Rubaie, Ali Abdul Hamza Hilal (2007)** A study of the problem of organic pollution and its biological effects on some aquatic organisms in the Baghdad region, PhD thesis, College of Education / Ibn Al-Haitham / University of Baghdad.
- **Al-Kubaisi, Abdul-Rahman Abdul-Jabbar; Al-Saadi, Hussein Ali and Ismail, Abbas Murtada (2001).** An ecological study of phytoplankton in the Tigris River before and after its passage through Baghdad. Journal of Environmental Research and Sustainable Development.
- **Al-Lami, Ali Abdul Zahra; Radhi, Aseel Ghazi; Al-Dulaimi, Amer Aref and Ali, Hassan Abdul (2005)** A study of some environmental factors in four freshwater ecosystems of varying salinity, central Iraq. Tikrit Journal of Pure Sciences.10(2001):35-30.
- Al-Hamdany, N.A., Al-Shaker, Y., & Al-Saffawi, A.Y. (2020). Water quality assessment using the NSFWQI model for drinking and domestic purposes: a case study of groundwater on the left side of Mosul city, Iraq. *Plant Archives* (09725210),20(1).
- Al-Shanona, R, AA, Al-Maathide A, TH, and Al-Asaaf, A, YR (2020). The environmental status of Tigris River water in Mosul city, northern Iraq. J of Plant Archives. (20) 1:3051-3056
- **APHA (2005)**. American Public Health Association. Standard method for the examination of water and waste water 23th ed., NW, Washington DC
- **Awad, AHMED, Eldeeb, HAZEM, and El-Rawy, MUSTAFA (2020).** Assessment of surface and groundwater interaction using field measurements: A case study of Dairut City, Assuit, Egypt. Journal of Engineering Science and Technology, 15(1), 406-425.
- **Ayanshola, AM, Sossou, PM, Bilewu, SO, Abdulkadri, TS, Oluwaseun, VO, and Owolabi, SO (2019).** Evaluation of The effect Precipitation variation on groundwater quality in ilorin metropolis,

Nigeria.1st International Conference on Engineering and Environmental Sciences, Osun State University. November 5-7, (2019): 524-535.

- Barzegar, Y., Gorelova, I., Bellini, F., & D'Ascenzo, F. (2023). Drinking water quality assessment using a fuzzy inference system method: a case study of Rome (Italy).International Journal of Environmental Research and Public Health,20(15), 6522.;https://doi.org/10.3390/ijerph20156522
- Cunningham, W.P.; Cunningham, MA & Saigo, BW (2007).Environmental Science A Global Concern. Ninth Edition. McGraw Hill Companies. New York.Inc.USA:620.
- **Gebbie, p. (2000).**Water stability.what does it mean and how do you measure it? 63rd annual water industry engineers and operators conference, held at Brauer College. Civic center – Warrambool, 6th September, 2000, 50-58 pp.
- **Hassan H, S., & Ali, J.**(2022). Study the quality of drinking water in the holy city of Karbala. Revis Bionatura 2022; 7 (2) 26. DOI. 10.21931/RB/2022.07.02.26
- **Ibo, E.M., Orji, M.U., and Umeh, O.R. (2020).**Seasonal Evaluation of the Physicochemical Properties of Some Boreholes Water Samples in Mile 50, Abakaliki Ebonyi State. South Asian Journal of Researc.h in Microbiology, 6(1):1-15.
- **Negi, P.; Mor, S. & Ravindra, K. (2020).**Impact of landfill leachate on the groundwater quality in three cities of North India and health risk assessment. Environment, Development and Sustainability, 22(2):1455-1474.
- **Rukavishnikov,**VS, Efimova, NV, Savchenkov, MF, Mylnikova, IV, & Lisovtsov, AA (2024). Quality of drinking water and risk to the health of the population of the south Baikal region (Russia). Emerging Contaminants, 10(2),
- **Varol, M,. Gokot, B., Bekleyen, A. and Sen, B. (2011).**Water qualityusing multivariate statistical techniques- A case study, river res appl., published online Library (Wileyonlinelibrary.com) Do: 10.1002/rra.
- **WHO (world health organization (2006).**Guidelines for safe recreational water environments vol. 2: Swimming pool and similar environments. Strategic Communications SA, Geneva.
- **WHO (World Health Organization). (2004)**Guidelines of drinking-water quality, vol.1. World Health organization, Geneva, Switzerland, p: 221-23.
- Yasmeen, Q., & Yasmeen, S. (2023). Impact of Drinking Water on People's Health and Water Borne Diseases: Impact of Drinking Water on People's Health.Pakistan BioMedical Journal, 31-35.
- Melo, S. & Haszar, V. L. M. (2000). Phytoplankton in an Amazonian flood-plain lakel Lago Batata, Brazil diel variation and species, Strategies V. Plankton Res.,22(1): 63-76.