Journal of Chemical Health Risks

www.jchr.org

JCHR (2023) 13(4), 1282-1293 | ISSN:2251-6727

Isolation and identification of some types of algae from the Tigris River as it passes through Tikrit city and their relationship with some physicochemical variables.

Lina Adnan Shakir Muhammad Al-Hadeethy [1], Raghad Mukdad Mahmood[2]

[1,2]Tikrit University, College of Education for Pure Sciences, Iraq, Tikrit

(Received: 02 September 2023 Revised: 14 October Accepted: 07 November)

KEYWORDS

Tigris River, filtration stations, algae and physicochemical variables

ABSTRACT: The current study was conducted in the period from July 2022 until June 2023 to test the seasonal biological, chemical and physical changes of the Tigris River water and the effect of its passage through the city of Tikrit on changing these properties. The results showed that electrical conductivity had differences in temporal and spatial values, with the lowest value in the summer and the highest value in the winter. The turbidity had significant differences in the temporal and spatial values at the study stations, the lowest value in the winter and the highest value in autumn. The results also indicate that there are no significant differences in the temporal and spatial pH values at the probability level of $p \leq 0.05$. The lowest value was in the winter and the highest value in the summer. The results also showed significant differences in the temporal and spatial values of total soluble solids. The value was lowest in the autumn and the highest value in the winter. Dissolved oxygen also had differences in spatial values, with the lowest value in the summer and the highest value in the winter. The results also recorded that the total basicity had differences in spatial values, where the highest value was in the winter and the lowest value in autumn. Likewise, the results for chloride ion recorded non-significant differences in the temporal and spatial values, where it reached the highest value in the winter and the lowest value in the summer. The results also showed that sulfate had differences in temporal values, reaching the highest value in the winter and the lowest value in summer.It was also observed that some types of algae were dominant in the study stations, such as: Oedogonium Spp and Navcula Spp. and Cladophora Spp. and Netrium sp. and Ulothrix sp.

1. Introduction

Algae are living organisms whose name comes from the Latin Algology or the Greek term Phycology, derived from the Greek word Phykos meaning seaweed or seaweed [1]. Algae are a group of self-trophic organisms characterized by the fact that they contain photosynthetic pigments. They are thallus plants (that is, their bodies are not divided into true roots, stems, and leaves, as is the case in vascular plants). Algae are among the largest plant phyla in terms of number. Their types and densities on Earth [2]. Algae are also considered one of the main products in aquatic systems and are one of the food sources for fish larvae and other aquatic plankton [3]. It contains chlorophyll a as a basic pigment in its composition, in addition to various other pigments. These pigments give it multiple colors and may overpower the green chlorophyll pigment [4]. Algae vary in size, from single cells so small that they cannot be seen with the naked eye to complex structures, multi-celled seaweeds up to several meters in length. Algae may be unicellular (motile or non-motile), colonies (motile or non-motile), filamentous (branching or non-branching), and may be of irregular shape (i.e. cell clusters) [5].

Algae are found in different environments. Most algae are aquatic. Some of them live in salt water and some live in fresh water in a form suspended within the water column called plankton, or in a form attached to a surface like plants, or they live on the bottom known as benthic. Some of them live in the dirt. In wetlands, on rocks or tree trunks, the other group also lives symbiotically with fungi, known as lichen [6].

2. Materials and methods

samples collection

Water samples were collected from five locations at different distances on the Tigris River passing through

Journal of Chemical Health Risks

www.jchr.org

JCHR (2023) 13(4), 1282-1293 | ISSN:2251-6727

the city of Tikrit within Salah al-Din province during four seasons (summer, autumn, winter, and spring), starting from July 2022 until June 2023, where samples were taken at a depth of about 10 cm. from the surface of the water and placed in 5-litre polyethylene bottles, after being washed twice with sample water at each station. Winkler bottles with a capacity of 250 ml were also used for the purpose of measuring the amount of oxygen dissolved in the water, and measuring the vital requirement for oxygen. The bottles were filled to their full capacity and without any air bubble so that the transportation process and the movement of the water would not affect changing a number of properties. The plastic bottles were closed well and the necessary information was recorded. Each bottle was then transferred to a 4C° refrigerator to conduct physical and chemical analyses. Various samples of phytoplankton were also collected using the network designated for collecting phytoplankton and algae. The samples were then transferred to the laboratory for examination and diagnosis. All of the aforementioned analyzes were conducted in the graduate laboratory of the Life Sciences Department, College of Education for Pure Sciences/University of Tikrit, the College of Engineering (Chemical Engineering Department), and the Salah al-Din Water Department (Quality Control Department).

Physical and chemical tests:

Electrical Conductivity

I use a Professional Benchtop conductivity meter type BC3020 after calibrating the device, and the results are expressed in µS/cm. The measurement was done directly during sampling.

Turbidity

A HANNA-LP 2000 Turbidity meter was used to express the results in Nephelometer Turbidity Unit (N.T.U.). The samples were shaken before measuring the turbidity for homogenization, and two average readings were taken for each sample.

pH

The pH measurement was taken using a Professional Benchtop pH meter, type BP3001, and the device was calibrated before measuring by using solutions with a pH of (4,7,9). The measurement was done directly during sampling.

Measurement of total dissolved solids (TDS)

The method described by the American Public Health Association [7], was followed by filtering 100 ml of the sample through 0.45 micrometer filter paper, then evaporating the filtrate in an oven at a temperature of (103-105) C to estimate the value of dissolved solids, and the results were expressed in units of milligrams per liter.

Measurement of dissolved oxygen (DO):

Dissolved oxygen was measured in the laboratory using a device (Oxygen meter lovibond) made in Germany and according to the method described in [7]. The device was calibrated at each reading by calibrating it with the amount of oxygen in the atmospheric air. The device reads (20.9), which is a quantity Oxygen in the atmospheric air, then the reading is converted to mg/L, and the oxygen in the water is measured.

Total Alkalinity

The total basicity was determined according to the method described by Welch [8], and the results were expressed in $CaCO_3$ in units (mg/L). 50 ml of the sample was taken and 3 drops of methyl orange indicator were added to it and flushed with sulfuric acid (0.02 N) until the color changed to Pink and take an average of two readings. The basicity of calcium carbonate ($CaCO_3$) is calculated according to the equation:

$$\text{T.Alk mg/l} = (V \times N \times 1000 \times \text{Equ.Wt.as } CaCO_3)/(V \text{ Sample})$$

where:

V = volume of standard solution of H_2SO_4

N = standard solution of H_2SO_4

Mole-wt = equivalent weight of $CaCO_3$

Chloride ion Ion Chloride

Chloride was measured according to the American Society for Testing and Methods [9] in water tests by taking 50 ml of sample water and adding some drops of potassium dichromate to it, then it was lubricated with a standard silver nitrate solution with a concentration of 0.025N until the color changed from yellow to brown red and was calculated. Chloride according to the following equation:

$$\text{Chlorinity(mg\textbackslash L)} = (V_{AgNo_3} \times N_{AgNo_3} \times 1000 \times \text{M.W.as } CaCO_3)/\text{V sample}$$

Journal of Chemical Health Risks
www.jchr.org
JCHR (2023) 13(4), 1282-1293 | ISSN:2251-6727

Sulphate SO4 measurement

Sulfate ions were estimated using the Turbidity Method, where a volume of (100 ml) was taken, then (5 ml) of the condition reagent was added, and it was shaken mechanically at a constant speed using a magnetic stirrer, then barium chloride crystals were added while the mechanical shaking continued for another minute. After that, the concentrations were read and calculations were made compared to the standard curve, and the results were expressed in mg/L [10].

Diagnosis of algae

Diatomosis of non-diatom algae

The algae samples were examined using a microscope under high and low power. The samples were fresh after the algae were well explained under the microscope. A counting cell with a size of 0.23 ml, which was made from glass microscope slides and thin slide covers, was used in the process of estimating the species density and was examined using an Olympus-CH compound light microscope. All samples were photographed using a HUAWEI P30 Pro mobile device.

Identification of diatoms

A drop of the sample was placed in the middle of a glass slide, dried on a hot plate at a temperature of 70 degrees Celsius, and a drop of concentrated nitric acid was added to it; To clarify the structures of the diatoms, after that they were left to dry, then a drop of Canada balsam was added to them and they were covered with a glass cover, so the samples were ready for examination [11, 12, 13, 14].

statistical analysis :

The results were analyzed statistically by applying the MINI TAB statistical program, the analysis of variance (ANOVA) test was applied, and the arithmetic means were compared with the Duncan multinomial test with a probability level of 0.05

3. Results and discussion :

Physical and Chemical traits of Water

Electrical Conductivity (EC)

The results in Figure (1) showed that electrical conductivity had differences in temporal and spatial values, but the temporal differences were significant at the probability level $p \leq 0.05$, and its values ranged between 440-548 micromm/cm, with the highest value recorded at 548 micromm/cm in the winter when The first station and the lowest value is 440 micromm/cm in the summer at the first station as well. Electrical conductivity may be affected by the seasons of the year and during the rainy season as it carries with it torrents of dust, in addition to various human and agricultural activities that may lead to an increase in electrical conductivity values, which It contains a large amount of dissolved salts [15]. In addition, its proportionality is directly proportional to the concentration of salts present, and it is a measure of the quality and quantity of ions dissolved in water [16].

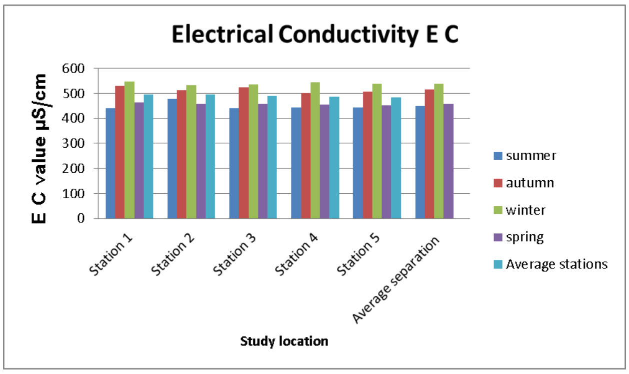


Figure (1) Spatial and temporal variation of the electrical conductivity value micromm/cm in the stations under study.

It was noted in our study that the values were high in the winter and the reason for the high electrical conductivity may be due to the erosion of quantities of soil found on both banks of the river into the main course of the river during the rainy season, which contributes to increasing the amount of dissolved salts in the water. Thirumulini & Joseph [17], also mentioned that conductivity has a relationship with dissolved solids (TDS) as a function of the type and nature of positive and negative ions dissolved in water. The results of the samples showed that the electrical conductivity did not excelled the classification of river water [18].

These values agreed to record the highest electrical conductivity values in winter with Al-Dulaimi and Khamis [19], as the values they reached ranged from 145-651 µS/cm, and Al-Dulaimi [20], and Al-Jumaili [21], where the two studies recorded the highest conductivity values of 630 and 673. µS/cm, respectively. The results were lower than what Al-Rawi [22], reached,

Journal of Chemical Health Risks

www.jchr.org

JCHR (2023) 13(4), 1282-1293 | ISSN:2251-6727

as he recorded values that ranged between 341-1684 µS/cm.

Turbidity:

The results in Figure (2) showed that the turbidity had significant differences in the temporal and spatial values at the study stations and the location during the study months at the probability level of $p \leq 0.05$, as the highest value was recorded at 21.4 NTU in autumn season at the first station, while the lowest value was recorded at 1. 79 NTU in winter at station 5.

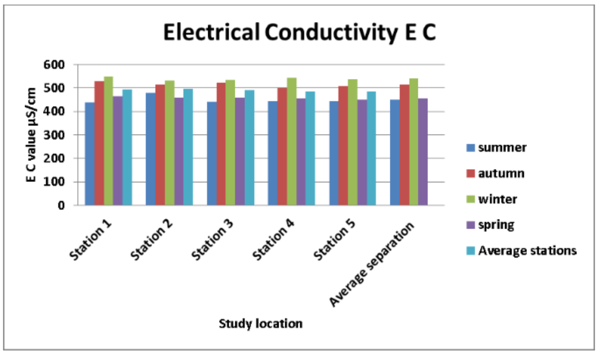


Figure (2): Spatial and temporal variation of NTU values at the stations under study.

The turbidity is classified according to the clarity of the water in terms of the turbidity values [60]. The turbidity values were different during the study period. This may be due to the fact that the factors causing the increase in their values are different, and the turbidity values in winter are affected by rainfall, which may lead to their increase. Because soil runoff occurs and thus reaches the river [23]. The highest turbidity values were recorded in March as a result of the rise in water levels, which in turn may have led to the erosion of rocks and dead plant parts, due to the rapid movement of water flow as well as the speed of the current [24].

The results were close to those reached by Madeed et al. [25], as they recorded values for turbidity that ranged between 21.6-28.9 NTU, and with Ismail [26], as their values ranged from 20.9-28.0 NTU, and less than Muhammad [27], as The turbidity values ranged from 25.4-40.1 NTU and Al-Majjami [28], whose results ranged from 0.340-60.50 NTU.

pH:

The results shown in Figure (3) indicate that there are no significant differences in the temporal and spatial pH values at the probability level of $p \leq 0.05$. The highest value was 8.1 in the summer at both the fourth and fifth stations, and the lowest value was 6.9 in the winter at the second station.

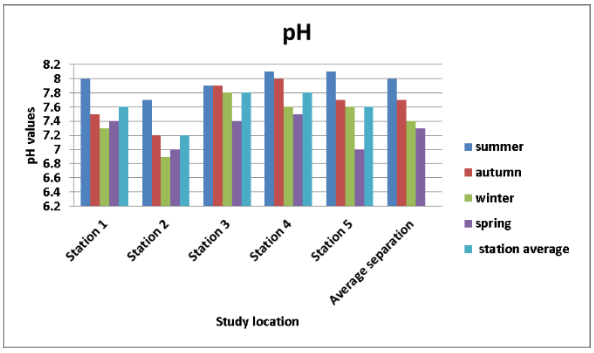


Figure (3) Spatial and temporal variation of pH values

The current results are consistent with what was reached by [29], and [30], during their studies, and the results of the current study were lower than what was recorded by Al-Sahn [31], as the pH values ranged between (8.4 - 7.3). The results of the statistical analysis showed that there were no significant differences between the stations, while significant differences were recorded between the months at a significant level of $P \geq 0.05$, and that the variation in pH values was simple, and this indicates the nature of the water in Iraqi rivers, which is often alkaline or tends to be alkaline. The pH results did not exceed the permissible limit for drinking water, 6.5-8.5, according to the Iraqi specifications for drinking [61].

Total Dissolved Solids (TDS):

The results in Figure (4) showed that total dissolved solids had significant differences in temporal and spatial values at the probability level of $p \leq 0.05$, where the highest value was 292 mg/L in the winter at the first station, and the lowest value was 222 mg/L in the fall. At the second stop.at the stations under study.

Journal of Chemical Health Risks
www.jchr.org
JCHR (2023) 13(4), 1282-1293 | ISSN:2251-6727

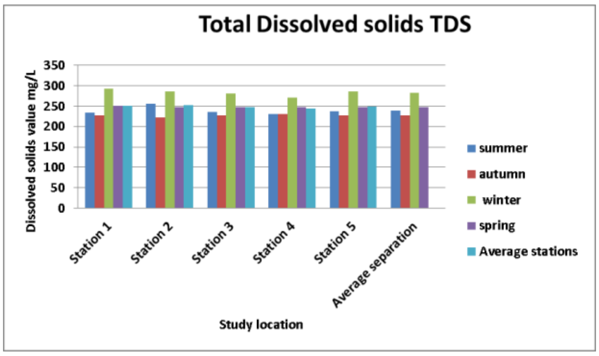


Figure (4) Spatial and temporal variation of dissolved solids values, mg/L, at the stations under study.

Dissolved solids are positively affected by electrical conductivity, and this is what was indicated, and also what was shown by the results of our study of electrical conductivity, as in Figure (1). Likewise, the amount of rain or floods that may result from it is also directly affected, in addition to being affected by river drainage and current speed [32]. Perhaps rainfall may lead to a significant increase in their values, as a result of surface soil runoff and its subsequent arrival into the river [32].

The results agreed with Mansour [33], and Ismail [26], as their result values ranged from 277-255 mg/L and 282-202 mg/L, respectively, and were higher than the results of Muhammad [27], as their result values ranged from 119-183 mg/L and less. From Al-Dulaimi [19], they recorded values ranging between 823-1600 and 190-325 mg/L, respectively.

Dissolved oxygen (DO):

The results in Figure (5) showed that dissolved oxygen had differences in spatial values, as the highest value was recorded during the winter, amounting to 8.2 mg/L at both the first and fourth stations, and the lowest value was 2.8 mg/L during the summer at Fourth stop.

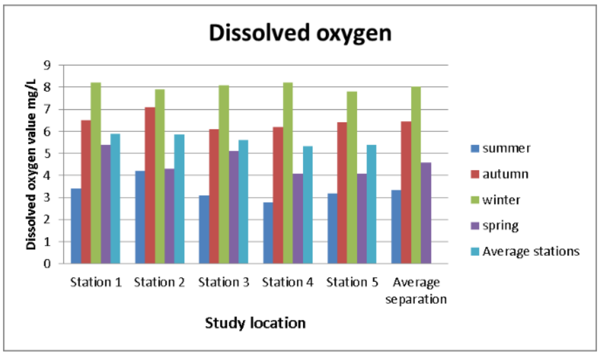


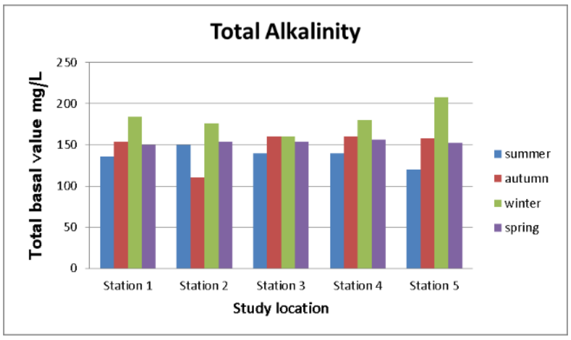
Figure (5) Spatial and temporal variation of dissolved oxygen mg/L at the stations under study.

Normal values for the level of dissolved oxygen in drinking station water depend on many factors, including the source of the water and the conditions of the surrounding environment. However, average values can be given that are general values for the normal level of dissolved oxygen in freshwater. These values are usually in milligrams per liter (mg/L) or dissolved oxygen in percentage (%). In unpolluted fresh water oxygen values can range The solute is between 7 and 9 milligrams per liter (mg/L), or about 70-90% of oxygen saturation under normal conditions. In winter, water with lower temperatures, such as cold water in rivers and lakes during the winter, dissolved oxygen values can generally be higher. As for water that is polluted or affected by organic flows, and in places affected by organic or industrial pollution, dissolved oxygen values may be lower than natural values [34].

Remember that these values are general estimates, and there may be significant variations depending on local conditions, water quality and other factors, in addition to temperature, atmospheric pressure, pollution level, and biological activity in the water. Water treatment plants need to monitor and review the dissolved oxygen level and ensure that it is in the appropriate range to support the ecological life and health of the treated water that will be used for distribution to consumers.

Total alkalinity:

The results in Figure (6) showed that the total basicity had differences in spatial values, as the highest value was 208 mg/L during the winter season at the fifth station, and the lowest value was 110 mg/L during autumn season also at the second station.



Journal of Chemical Health Risks
www.jchr.org
JCHR (2023) 13(4), 1282-1293 | ISSN:2251-6727

Figure (6) Spatial and temporal variation of total basal values, mg/L

The results of the current study were of a wide range than those mentioned by [51], as the values of alkalinity were between 146 - 230 mg/L, for the Tigris River in the city of Tikrit within the Salah al-Din province , and are not identical to the study of Al-Sultan [35], who indicated that the range of alkalinity ranges. Between 145-240 mg/L for the Tigris River in the city of Mosul, and it was close to the results reached by [52] and Al-Hamdani [36], as it reached 82-210, 92-202 mg/L, respectively.

Observing the results of the current study, we find that all values obtained for basicity in water samples were within the permissible limits for drinking water, as the World Health Organization (WHO) (2008) set 250 mg/L as the maximum permissible limit for calcium carbonate CaCo3 in potable water. The results of the statistical analysis showed that there were no significant differences between the stations, while significant differences were recorded between the months at a significant level of $P \geq 0.05$.

Alkaline compounds contribute to influencing and changing the pH of water, and contamination with them leads to the formation of salts such as carbonates, bicarbonates, hydroxides, and chlorides. In many locations, these values excelled on the permissible limits set by the World Health Organization (350 mg/L), and this is due to the limestone nature and the geological structure of the region [37].

Chloride ion (Cl- (Chloride Ions):

The results in Figure (7) showed that the chloride ion had non-significant differences in temporal and spatial values, as the highest value was 43 mg/L in the winter at the fourth station, and the lowest value was 27 mg/L in the summer at the second station.

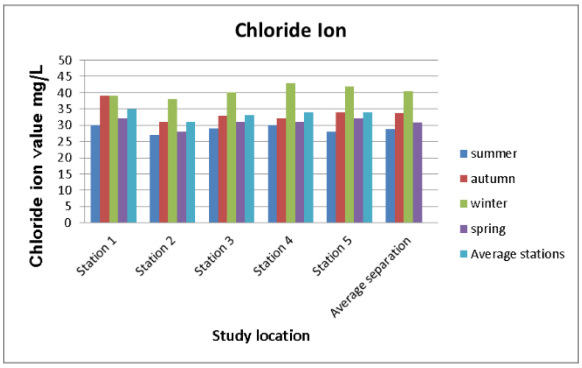


Figure (7) Spatial and temporal variation of chloride ion values mg/L at the stations under study.

The reason for the increase in the concentration of chlorides in water samples may be the result of the presence of this ion in high concentrations in the soil and rocks, and thus a dissolution process occurs when contact with water occurs. This leads to an increase in its concentration in the water, and its presence may be the result of waste water. And sewage, which is often rich in this ion Grode & Jadhav [38].

These values agreed with the study of [53], as his results ranged between 15-30 mg/L, and converged with [54] and [55], as their results ranged from 13.8-33 mg/L and 20.6-37 mg/L, respectively. It is lower than the results of [56], [57], and Al-Sultan [35], as their results ranged between 17.7-58.5, 170-17.75, and 30-60 mg/L, respectively.

Sulphur:

The results in Figure (8) showed that sulfate had differences in temporal values, as the highest value was 103 mg/L in the winter at the third station, and the lowest value was 70 mg/L in the summer at the fourth station.

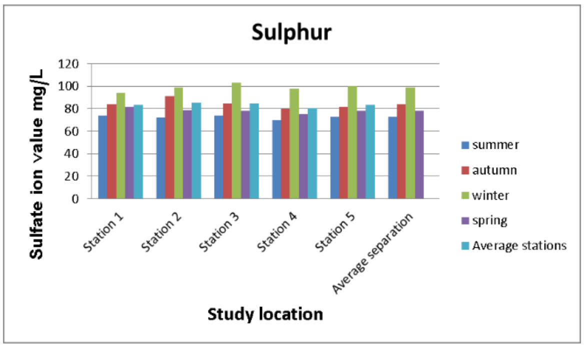


Figure (8): Spatial and temporal variation of sulfate values mg/L at the stations under study.

Journal of Chemical Health Risks
www.jchr.org
JCHR (2023) 13(4), 1282-1293 | ISSN:2251-6727

The natural source of sulfates is rainwater [39], either from groundwater or surface water, the dissolution of gypsum layers through the passage of water over the rock layers containing the gypsum, or the oxidation of sulfates such as iron sulfide [40]. The World Health Organization sets the level of sulfate in drinking water at 400,200 mg/L [41].

The source of sulfates in the study area results from the dissolution of gypsum soil components [42], and this is due to ion exchange between the sulfate ion present in the soil and the water ion [40]. As a result of the soil being washed away by rainwater falling on the study area [42].

Types of algae isolated from the studied stations:

Different types of algae were isolated from water sources in the studied stations, as shown in Table (1).

The species identified from the first station were: Bambsina sp. ,

Cladophora Glomerata, Navicula SP., Achanathes Clevel, Ulothrix Aequalis, Ulothrix Zonata, Oedogonim Aureum, Oedogonium Lattuniarum, Aphanochae SP. Occs Turgidus, while the second station was most of the diagnosed species: Oedogonium Isolatum, Oedogonium Persheimii, Synedra SP ., Netrium sp., Navicula standeriella, Navicula goppertiana, Surirella robusta, Trachelomonas abrupt. The third station, from which four species were isolated: Chadophora glomerata, Netrium sp., Pandoriua sp., Ceratium spp., Figure (4-3), and the station The fourth station also isolated four species: Chadophora glomerata, Navicula sp., Amphora sp., Endorina. As for the fifth and last station, Chadophora glomerata, Navicula standeriella, Netrium sp. were isolated from it. and Stephanodiscus.

Appendix (20): Types of algae isolated from the studied water plants

spring	**winter**	**autumn**	**summer**	Station
Netrium sp. *Cladophora glomerata* *Navicula standeriella* *Surirella Helvetica*	*Netrium sp.* *Cladophora glomerata* *Navicula standeriella* *Lepocinclis sp.*	*Spirogyra sp.* *Cladophora glomerata* *Navicula* sp. *Achanathes clevel* *Chadophora sp.* *Netrium sp.* *Euodorina*	*Bambsina* sp. *Cladophora glomerata* *Navicula* sp. *Achanathes clevel* *Ulothrix aequalis* *Ulothrix zonata* *Oedogonim aureum* *Oedogonium lattumniarum* *Aphanochaete* sp. *Netrium* sp. *Chroococcs turgidus*	Station 1
Euglena acus *Cladophora glomerata* *Euglina gracilis* *Azpeitia tabularis*		*Oedogonium sp.* *Spirogyra* *Synedra ulna* *Netrium* sp.	*Oedogonium isolatum* *Oedogonium pringsheimii* *Synedra* sp. *Netrium* sp. *Navicula standeriella* *Navicula goppertiana* *Surirella robsta* *Trachelomonas abrupt*	Station 2

Journal of Chemical Health Risks
www.jchr.org
JCHR (2023) 13(4), 1282-1293 | ISSN:2251-6727

Chadophora glomerata Netrium sp. Pandorina sp. Ceratium spp.	*Cladophora glomerata Synedra ulna Netrium oblongum sp. Chroococcs turgidus*	*Chlorella vulgaris Spirogyra sp. Pandorina Euglena*	*Cladophora glomerata Netrium* sp. *Oedogonium* sp. *Cladophora* crispate	Station 3
Navicula sp. Amphora sp. Eudorina Chadophora glomerata	*Navicula standeriella Netrium sp. Synedra ulna Chodophora glomerata*	*Cladophora glomerata Chlorella sp. Nestrium,Navicula sp. Achanathes clevel*	*Cladophora glomerata Lepocinclis salina Oedogonium sp. Surirella robsta*	Station 4
Navicula standeriella Netrium Stephanodiscus Chadophora glomerata		*Cladophora glomerata Spirogyra Heterococcus chodatii Diatome sp.*	*Surirella robsta Cymatopleura elliptica Navicula standeriella Stigeoclonium sp. Cladophora glomerata Scytonema sp. Craticula halophile Lepocinclis fusiformis Diatome sp.*	Station 5

Algae generally live on the surface of the water as well as in its depths and are found in all water sources exposed to sunlight, while a small amount of algae is found in the soil and on surfaces exposed to the air. Most algae are actually aquatic and grow in the water of ponds, lakes, reservoirs, rivers, and oceans [43].

Algae are characterized by their ability to form large quantities of organic matter in water. For example, more than 130 tons of algae flow daily into the Fox River in the American city of Wisconsin from Lake Winnipegoah, while the maximum concentration of aquatic microscopic suspended algae has reached one of the Ohio rivers (Ohio) [44].

Such large quantities of algae are considered one of the most important causes of serious problems in water filtration plants, and small numbers of certain algae such as diatoms, Melosira, syncdra and tabcllaria (Mclosira, syncdra and tabcllaria) cause problems as they steadily reduce the longevity of the filter, and brown dinoflagellates are characterized Senora, even if they are few in number, have an unpleasant, undesirable taste and produce odor. Despite the above, the presence of most algae in low concentrations is beneficial in raw water [45].

The massive growth of algae causes some difficulties, such as closing the water filter screens. It also causes a change in the taste and smell of the water if anaerobic respiration occurs. Algae blooms and mats cause the death of fish because they prevent the penetration of atmospheric oxygen into the lower layers of water [46].

Algae may be a thin, sticky, colloidal gelatinous layer on the surface of the gravel used to filter water. It gradually reduces the speed of the water through these filters, but at the same time it performs useful services, where it adds oxygen to the water, which helps in decomposing organic materials aerobically by the bacteria on the filter. Instead of anaerobic activities in the gravel layer that make the leachate or water less tasty. Therefore, it has become necessary to determine the phytoplankton present in the aquatic environment because it is an indicator to determine the amount of pollution of the area. Torres [47] stated that marine microalgae are an indicator of organic & non-organic pollution.

Journal of Chemical Health Risks

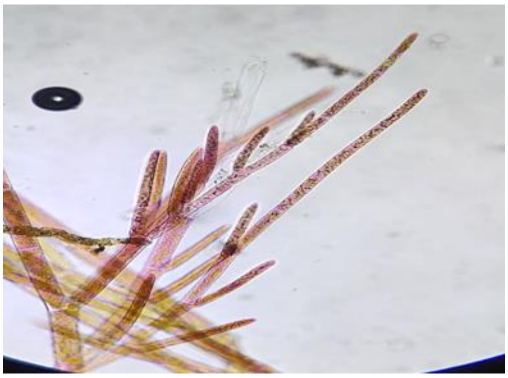
www.jchr.org

JCHR (2023) 13(4), 1282-1293 | ISSN:2251-6727

Macleod [48], also pointed out that organic pollution and other types of pollution affect the ecosystem, and the changes that occur in biotic communities can be identified in response to the pollution occurring. Among these primitive organisms that are studied are algae or phytoplankton that are found suspended in water. In the current study, the algae section Oedogonium sp. and Netrium sp. Cladophora glomerata has clear dominance in the number of species recorded at the study stations, and a similar study was observed by a number of researchers in Iraqi waters [49,50].

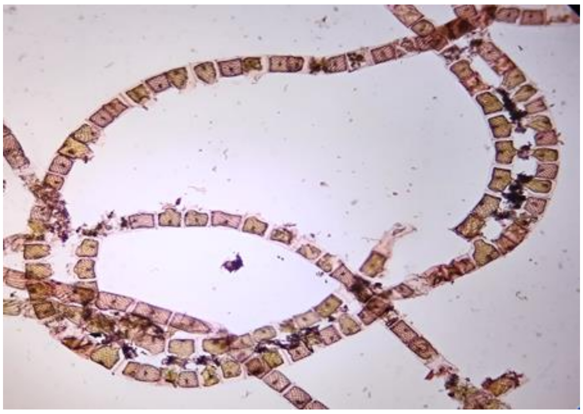
A study by Al-Safi and Al-Moussawi [51] showed high diversity in one station, as the highest degree of diversity was recorded at 2.9 in autumn season for the station's outlet water. This may be due to moderate temperatures, which encouraged the growth and flourishing of algae, and the diversity of algae in clean water is highly variable. It is not limited to the dominance of one or two species, but rather many species can be diagnosed and their dominance [58], while no diversity was recorded in the summer for the same station. This may be due to the high temperatures, which affects the growth and flowering of algae, and may also be due to the process of adding chlorine and other chemicals for sterilization. And water filtration. Antonio [52], mentioned that the growth of these algae in high concentrations releases toxins, but these toxins are broken down by the process of adding chlorination during sterilization. There are no previous studies in the study area on diversity.

The results of the diversity function indicated a large diversity of phytoplankton throughout the year in the first and second stations compared to the other stations. This may be due to the abundance of suitable conditions that encourage the growth of these species, such as (temperature, pH, and abundance of nutrients), while the lack of diversity in the other stations. It may be due to the algae in this station being affected by a specific food source, coupled with the small number of species and the excessive increase in individuals per species [53].



Cladophora glomerata

Ulothrix aequalis



Spirogyra sp.

Netrium sp.

Refrences

1. Prescott L. M., Harley, John, P., and Klein, Donald, A. Microbiology. Six Edition. McGraw-Hill Companies. New York. Inc. USA. 992p. 2005.
2. Mouloud B.k., Suleiman N.I., and Al-Basam I. T., Algae and argans. Dar Al-Hekma Press. University of Baghdad. 599 p. 1990.
3. Das N.P., Kumar A, Singh P.K., Cyanobacteria, pesticides and rice interaction. Biodiversity and Conservation. 2015 Apr;24:995-1005.
4. Al-Shishani, B.I., (2005). A comparative environmental study of algae in some streams of Diyala Governorate. Master's thesis/College of Science - Al-Mustansiriya University.
5. Sze P.A Biology of Algae. The Mc Graw-Hill companies1998. U.S.A. 1-15p.
6. Al-Mayah, A.R., Akbar A., Al-Hamim F. I. Aquatic plants and algae. Parts one and two. Dar Al-Hekma Press. University of Basra. 1991. 735 p.
7. Beutler M, Wiltshire KH, Meyer B, Moldaenke C, Luring C, Meyerhofer M, Hansen UP. APHA (2005), Standard Methods for the Examination of Water and Wastewater, Washington DC: American Public Health Association.
8. Ahmad SR, Reynolds DM. Monitoring of water quality using fluorescence technique: prospect of on-line process control. Water Research. 1999 Jun 1;33(9):2069-74.
9. Welch PS. Limnological methods. McGraw Hill, book company Inc1984. 382 pp.
10. ASTM. Annual Book of ASTM standard (American Society for Testing and Materials) printed in Easton 1984. Md U.S.A
11. Abbawi SA, Hassen MS. Practical Engineering for the Environment (Water Tests). Dar Al-Hikma for printing and publishing, Mosul. 1990.
12. Prescott G.W. How to kow the fresh water 3rd ed, William Brown Co., Publishers, Dubuque.lowa. 1979.348 pp.
13. Taylor JC, Harding WR, Archibald CG. An illustrated guide to some common diatom species from South Africa. Pretoria: Water Research Commission; 2007.
14. Wehr JD, Sheath RG, Kociolek JP, editors. Freshwater algae of North America: ecology and classification. Elsevier; 2015 Jun 5.
15. Guiry MD, Guiry GM. AlgaeBase, World-wide electronic publication, National University of Ireland, Galway, Ireland, 2021.
16. Al-Sarraj ES. Ph.D.Thesis Biology, Zoology, College of Science University of Mosul,(In Arabic). 2013.
17. Bhat MA, Wani SA, Singh VK, Sahoo J, Tomar D, Sanswal R. An overview of the assessment of groundwater quality for irrigation. J Agri Sci Food Res. 2018;9(1):209.
18. Thirumalini S, Joseph K. Correlation between electrical conductivity and total dissolved solids in natural waters. Malaysian Journal of Science. 2009 Apr 23;28(1):55-61.
19. NHVRAP (New Hampshire Volunteer River Assessment Program). Interpreting VRAP Water Quality Monitoring Chemical parameters, UK. 2011.
20. Mohammad HH, Khamees HS. Diagnostic study of some types of algae present in the Tigris River passing through the city of Dhuluiya, Salah al-Din. Samarra Journal of Pure and Applied Science. 2021 Sep 29;3(3):95-107.
21. Hamad AA. An environmental and diagnostic study of algae in the waters of the Tigris River, south of the city of Samarra. Master's Thesis/College of Science, Tikrit University.2013.
22. Al-Jumaili, A.K.H. A monological study in the Tigris River within Salah al-Din Governorate. Master's thesis/College of Science - Tikrit University, Iraq. 2011.
23. Allawi AJ. Determining some chemical and biological characteristics of the sediments of several sites from the Euphrates River within Anbar

Governorate. Doctoral thesis, College of Education for Pure Sciences - Tikrit University. 2021.

24. Wolde AM, Jemal K, Woldearegay GM, Tullu KD. Quality and safety of municipal drinking water in Addis Ababa City, Ethiopia. Environmental Health and Preventive Medicine. 2020 Dec;25(1):1-6.
25. Taun PT., Dung MT., Duc PT., Trang HM., Khai NM., Thuy PT. industrial water mass balance as tools for water management in industrial parks, Elseveir, water resource and industry 13:14-21. 2016.
26. Mudeed MM, Mahmoud AJ, Owaid YH. Environmental and Diagnostic Study of External Parasites of Some Fish of Lower Zab River and Development Ponds Fishes in Kirkuk Governorate. Kirkuk Journal of Science. 2020 Jun 1;15(2):79-96.
27. Ismail HM. The effect of environmental pollutants on ectoparasites in three species of Tigris River fish. Master's thesis, College of Education for Girls / Tikrit University. 2018.
28. Muhammad EH. The effect of environmental conditions of the water of the Little Zab River within the Altun Kupri district on the infestation of three types of fish with external parasites. Master’s thesis/College of Education for Girls, Tikrit University. Iraq. 2021.
29. Al-Majjami GSS. Evaluation of some physical, chemical and bacteriological characteristics of the Ishaqi River in Salah al-Din Governorate. Master's thesis, College of Science - Tikrit University. 2022
30. Hussein WS., Ibrahim M., Azouz A. Evaluating the efficiency of two drinking water purification plants within the city of Karbala - Karbala Governorate - Iraq. University of Karbala, the second scientific conference of the College of Science. 2014.
31. Al-Sulaiman FA, Al Fahdawi SS, Al Qaisy SA. Detection of Structural Control on Formation Water Quality, in Hemrin Oilfield, northern Iraq, Using Lineament Analysis and Hydrochemical Data. Tikrit Journal of Pure Science. 2017;22(2):145-58.
32. Al-Sahn I., Sami M. The effect of the morphological and anatomical characteristics and chemical content of the Nile flower plant on the physical and chemical characteristics of specific sites of the Tigris River in the Nineveh and Salah al-Din governorates, published master’s thesis, College of Science - Department of Life Sciences, Tikrit University. 2019.
33. Al-Mashhdani MHS., Abdul-Aziz YTS., Omar MR. International and Scientific Conference Followed by the College of Science University of Tikrit, pp:38-40.(In Arabic). 2018
34. Mansour MA. The effect of some environmental aspects on the infection of three species of Lesser Zab River fish with ectoparasites in the city of Kirkuk. Master Thesis. College of Education for Girls - Tikrit University. 2019
Awad AH, Eldeeb HA, El-Rawy MU. Assessment of surface and groundwater interaction using field measurements: A case study of Dairut City, Assuit, Egypt. J. Eng. Sci. Technol. 2020 Feb;15:406-25.
35. Al-Sultan, FMH. Evaluating the efficiency of the Old Left Liquefaction Station and indicating the sources of pollution in the conveyor lines. Master Thesis. College of Environmental Sciences and Technologies - University of Mosul. 2019.
36. Al-Hamdani, AS. To evaluate WQI, apply the water quality index. Water in some neighborhoods of Mosul. Master's thesis. College of Education for Pure Sciences - Life Sciences. 2018.
37. Rodier J, Legube B, Merlet N, Brunet R, Mialocq JC, Leroy P. L’analyse de l’eau-9e éd. Eaux naturelles, eaux résiduaires, eau de mer. Dunod. 2009:564-71.
38. 37. Grode, S.P. & Jadhav, M.V. (2013). Assessment of water quality parameters: a review. J Eng Res Appl 3(6):2029-2035.

39. Ghazali D, Zaid A. Etude de la qualité physico-chimique et bactériologique des eaux de la source Ain Salama-Jerri (Région de Meknès-Maroc). LARHYSS Journal P-ISSN 1112-3680/E-ISSN 2521-9782. 2013 Jan 18(12).
40. Al-Kindi GYR. A qualitative survey of ground and surface water in the city of Al-Kadhimiya', Journal of Engineering and Technology, Volume 2009. 27, p. 540.
41. Al-Hayek N. Water pollution and purification (University Publications, Algeria). 1989.
42. Mahmoud SM. Water sources and future solutions to solve the problem of water scarcity (Dar Al-Kitab Al-Hadith). 2009

43. Omar WM. Perspectives on the use of algae as biological indicators for monitoring and protecting aquatic environments, with special reference to Malaysian freshwater ecosystems. Tropical life sciences research. 2010 Dec;21(2):51.
44. Necchi O. (ed.) River Algae. Springer, Necchi, Orlando J.R. 2016.
45. Keeling PJ. Diversity and evolutionary history of plastids and their hosts. American journal of botany. 2004 Oct;91(10):1481-93.
46. Smol JP, Stoermer EF, editors. The diatoms: applications for the environmental and earth sciences. Cambridge University Press; 2010 Sep 30.
47. Torres MA, Barros MP, Campos SC, Pinto E, Rajamani S, Sayre RT, Colepicolo P. Biochemical biomarkers in algae and marine pollution: a review. Ecotoxicology and Environmental Safety. 2008 Sep 1;71(1):1-5.
48. Macleod H. Organic pollution of hamilton harbour.Toxicity information for various groups of aquatic life". www.science. Mcmaster.ca. 2009.
49. Al-Zubaidi AJM. Species composition and seasonal variations of the epipelic diatoms in some Southern Iraqi Marshe. Marina Mesopotamica,15(1): 53-67. 2000.
50. Al-Maliki NSH. Environmental survey of the Hamdan Canal, one of the main branches of the Shatt Al-Arab River. Master's thesis, Agricultural Sciences/Fish and Marine Resources, College of Agriculture, University of Basra: 72. 2002.
51. Al-Safi AG., Al-Moussawi NJ. Study of some physical and chemical factors and the qualitative composition of phytoplankton for the two domestic waste treatment plants in Hamdan and the treatment of wastewater supplied to the city of Basra in Al-Baradhiyah. College of Science, University of Basra. 2010.
52. Antonio CP. Blue green algae affects water supply". www.tooowbarc.gld.gov.au. 2009
53. Atkins WA. Pollution of the ocean by sewage, nutrients, and chemicals. www.water encyclopedia.com. 2007.
54. Fartum, Zuhair Farouk Ahmed (2018). Evaluating the efficiency of four drinking water filtration units in Salah al-Din Governorate, Master's thesis, College of Science/Tikrit University.
55. Al-Jubouri, Muhannad Hamad Saleh Saeed (2009). An environmental and diagnostic study of algae in cross-sections of the Tigris River within Salah al-Din Governorate, Master's thesis, College of Science/Tikrit University
56. Hussein, Moaz Ali (2018). Parasitic infections in three types of fish from the Tigris River passing through the city of Tikrit/Salah al-Din Governorate. Master's thesis, College of Education for Girls / Tikrit University.
57. Al-Hadidi, Amna Fares Farhan (2018). Evaluation of the water quality of the Tigris River in the area between the Mosul and Qayyarah Dam for various uses, Master's thesis, College of Environmental Sciences and Technologies/University of Mosul.
58. Abbawi, Souad Abd and Elia, Hala Nabil (2012). Treating the water of the Al-Khosar River in the city of Mosul using alum and activated carbon. Al-Rafidain Science Magazine. 21 (1): 78–67.
59. Ibrahim, Muhammad Saleh Arhaim (2020). The environmental reality of water filtration plants in Al-Awja and Al-Zalaya districts in Salah al-Din Governorate. Master's thesis, College of Science, Tikrit University.
60. Water watch.(1997). Australia, Module 4-physical and chemical parameters "Methods Turbidity"
61. Macleod, H. (2009). Organic pollution of hamilton harbour.Toxicity information for various groups of aquatic life". www.science. Mcmaster.ca