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The effect of Medical City waste on the quality of plankton diatoms in Tigris River at central Baghdad

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Abstract

A quarterly qualitative study of the plankton diatoms within the waters of the Tigris River was conducted, starting from September 2022 until May 2023, to find out the effect of the liquid medical city waste released to the Tigris River on the quality of plankton diatoms within Tigris River for three sites confined between Al-Sarafiya Bridge in the north and Medical City Bridge, the site of Al-Khader Elias in the south, and the middle site affected by sewage waste for the Medical City Hospital Compound, with the study of some physical and chemical variables of the river water. The study was able to record 94 species of diatoms belong to the 26 genera in which pennate diatoms prevailed 74 species belonging to 21 genera while the centric diatoms recorded a smaller number of 20 species belonging to 5 genera. The study also showed the effect of sewage water for hospitals Medical City on the quality of diatoms, which it was few throughout the study period and the waste loaded with organic matter and antibiotics with high concentrations caused a decrease in the number of diatoms species throughout the study period within the site directly affected by waste.

Keywords: Medical City waste, Plankton diatoms, Tigris River, Baghdad.

Introduction

Water is a necessary and important element for life on the surface of the earth and the hydrosphere constitutes 79% of the Earth's area, and includes lentic and lotic water, fresh and salty, snow and moisture. Although fresh water is the most important, its percentage is small compared to salt water on the surface of the earth (Al-Muthanani and Al-Salman, 2009; Al-Janabi, 2011), most living organisms live in water and it is two-thirds of the human weight, and represents 9/10 of the plant size. Water is used in many areas of daily life, whether it is agricultural, domestic or industrial consumption (Isehak, 2001; Ibrahim, 2012). The chemical and physical properties of water as well as biological properties are among the most important indicators affecting water quality (Salih *et al*., 2018). There have been many studies on the physical,chemical and hydrological properties of water to know its impact on the surrounding environment (Salman et al.2022).

Algae are a widespread group of organisms, the majority of which are aquatic living with the ability to carry out photosynthesis, simple in composition, their reproductive bodies lack a sterile wall, play a major role in stabilizing the ecosystem, and have a wide range of vegetative forms, some of their prokaryotic genera and the vast majority are eukaryotic (Wehr and Sheath, 2003).Many studies have addressed the relationship of algae to the growth of different types of bacteria different environments, including polluted environments. (Ibrahahim at al.2020),Many studies were conducted in the local Iraqi environment, which dealt with studying the quality and classification of algae in the soil of some areas of Baghdad -Iraq. (AL-Magdamy, 2019)

Algae are divided into eight main sections according to special foundations, with diatoms forming the largest part, belonging to Divission: Chrysophyta and the class: Bacillariophyceae. Diatoms are widespread unicellular algae found in all salty and fresh aquatic environments, whether running or stagnant, and they exist either planktonic or benthic and the benthic are either epiphytic or epipelic or epizamic or epizoic, meaning that they are called according to the medium of their adhesion (Al-Husseini and Salman, 2020).

Diatoms are distinguished from other algae in that they have a wall thickened with silica (SiO_2) called the Frustule, divided into two halves called valve,

one upper and the other lower, and overlapping one with the other and both connected to connecting band. The etymology of the word diatom is Greek meaning something divided in half (Al-Bouaji, 2015).

Medical waste resulting from hospital activities causes a great danger to water and the chemicals, radioactive substances and antibiotics are involved in water pollution and affect its quality (Twinch, 2019).

Some sources suggest that antibiotics can adversely affect the photosynthesis of autotrophic organisms, including eukaryotes and prokaryotes (Siedlewicz *et al*., 2018). The mechanism of action of some antibiotics depends on disrupting DNA replication or protein synthesis in blue-green algae, while in green algae it can be associated with inhibition of photosynthesis processes leading to growth inhibition (Halling *et al*. 1998; Gonzalez *et al*., 2013; González *et al*., 2019).

As for diatoms, antibiotics affect them significantly and they reduce the efficiency of their use of light, that mean affect the process of photosynthesis, which leads to a lack of species in the environment exposed to antibiotic contamination, blue-green algae are characterized by the resistance of some types to high concentrations of antibiotics, unlike diatoms, which affect the presence of acceptable environmental concentrations of antibiotics in the construction of all their bodies from the silica, thus the reproduction stops and the types of diatoms are reduced (Guo *et al*., 2016).

Abdul Saheb *et al*. (2022) indicated that 31 genera of pennales were recorded, including 160 species, and 173 species belonging to 37 genera were identified through the study, including 6 genera of centric diatoms.

It prefers marine water and it is sensitive to many pollutants, especially herbicides that enter the aquatic environment, while pennales diatoms are more resistant.

Material and Methods

Study area: Baghdad city is located at latitude of 33.34 and a longitude of 44.40 and above sea level with an estimated height of 41 meters and is divided by the Tigris River into Al-Karkh and Al-Rusafa, the medical city hospital is located to the left of the Tigris River next to Al-Rusafa. Its impact is limited between Al-Sarafiya Bridge in the north and Bab Al-Mu'adam Bridge in the south (Mostafa *et al*. 2007) (Figure 1). The Medical City is one of the most famous health institutions in Baghdad and includes the largest hospitals in it, and these hospitals dispose of their waste from sewage directly to the Tigris River without treatment at a rate of three to four times a week and at a rate of three hours in the morning and another in the evening (Abdul Majeed *et al*., 2022). These wastes affect the physicochemical properties of river water and change the quality of plankton algae, so they need periodic checks of river water (Wahhab *et al*., 2023).

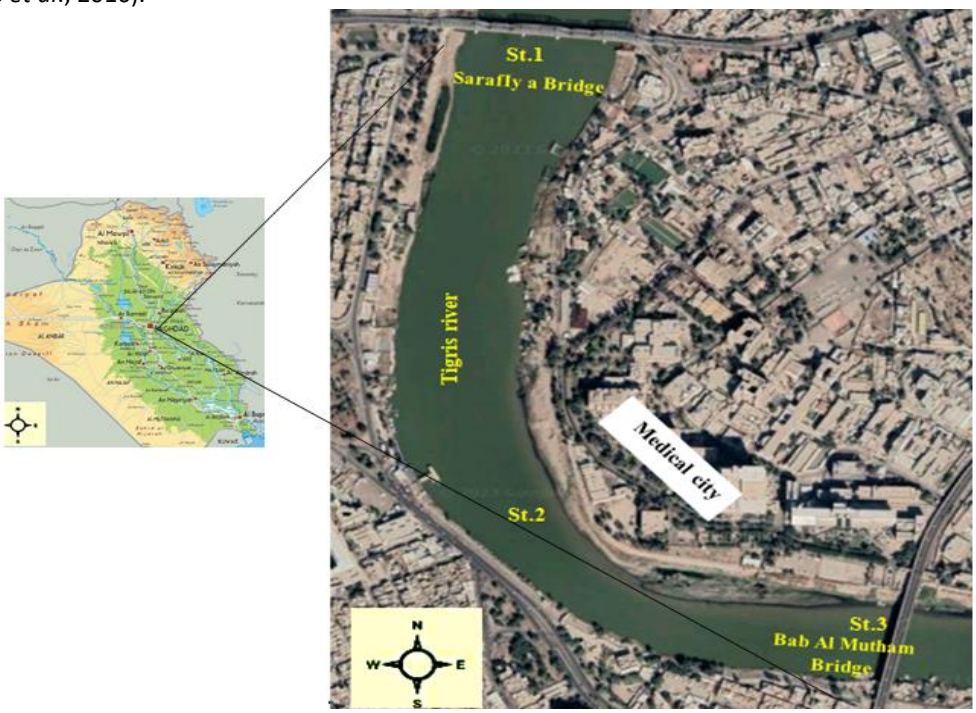

Figure (1): Map of the study area

Sample collection: The samples were collected three season every month, from three sites were chosen to collect samples, the first near Al-Sarafiya Bridge, north of the Medical City, and the second near to the site of the release Medical City waste water in the Tigris River, the third site was located south of the Medical City, Al-Shaljiyeh region, near the Bab Mu'adam Bridge (Fig. 1). The samples collected from Oct 2022 to June 2023 and represented as seasons. The field are water temperature (C), pH were measured by the digital portable multimeter, total nitrogen (mg/l), total phosphate and silica (mg/l), estimated by methodology of Apha (2017).

Phytoplankton sample: Plankton algae were collected using a phytoplankton network with a diameter of 20 µm and the filter models were placed in polyethylene bottles and preserved by adding Lugel solution (Furet and Benson-Evans, 1982).

The species of the diatoms class were diagnosed after dissolving the organic matter and clarifying their diatomic structures using concentrated nitric acid (Patrick and Reimer, 1975) and examining them with magnification power (100x) depending on numerous sources and on magnification power (10x, 40x, 100x) (Patrick and Riemer 1975; 1966; Germain, 1981; Hassan *et al*., 2012, Munir *et al*., 2012; Al-Hassany and Hassan, 2014).

Water systems are exposed to various environmental factors, whether geological related to the nature of the water body or climatic changes and human activities, change the different properties of water and the pattern of distribution of algae is related to the chemical and physical properties of river water, meaning that these factors determine the stability of food chains in the aquatic environment (Hassan *et al.*, 2018). Table (1) indicates the results of the factors studied.

Table (1): General means, standard deviation and range for the characteristics studied by station.

Variables	Range: Minimum –Maximum Mean ± SD			LSD
	ST.1	ST.2	ST.3	
Water temperature °C	8.00-21.00	8.00-21.66	9.00-22.00	7.154 N.S
	16.81 ±6.36	16.99 ±5.24	16.96 ±5.77	
pH	6.85-7.37	6.32-7.29	6.59-7.38	0.207 *
	6.97 ±0.08	6.88±0.22	7.06 ±0.16	
PO_4	1.74 -3.68	3.15-3.83	1.74 -3.68	0.411 *
	2.56 ±0.50 b	3.54 ±0.20 a	2.53 ±0.19 b	
NO_3	10.21-17.92	13.50 -18.90	8.60-18.48	2.165 *
	12.16 ±1.05 b	15.80 ±2.66 a	10.93 ±1.03 b	
Sio_3	1.74 - 3.69	3.44 - 3.70	1.60-1.98	2.115 *
	2.56 ±0.50 b	1.80 ±2.66 a	1.93 ±1.03 b	
Tetracycline	0.00 -0.00	32.00 -65.70	0.00 -0.00	12.831 *
	0.00 ±0.00 b	54.61 ±18.6a	0.00 ±0.00 b	
Levofloxacin	0.00 -0.00	18.00 -33.80	0.00 -0.00	5.855 *
	0.00 ±0.00 b	29.72 ±8.24a	0.00 ±0.00 b	

Mean with different letters within the same row differ significantly among themselves
*** (P≤0.05), NS: Non-significant.**

Temperatures recorded a slight variation in their values between the sites, and the highest rate of 22 °C was recorded in May in the third site and the lowest rate of 8 °C in the first and second sites during December, non- significant differences were observed between the sites, and this difference is due to a difference in the times of water sampling and the difference in temperatures between the summer and winter months, and this is agree with local study (Alwan *et al*., 2017).

pH is one of the important factors in modifying the nature of water acidity and its basics, and is affected by CO_2 gas, hydrogen sulfide and ammonia, as well as in carbonate ions and bicarbonates available in water (Goldman and Horn, 1983; Van Dolah *et al.*, 2002).

Results and Discussion

The results of the study showed that the highest pH value was recorded in the third site during February 7.38, while the lowest value was recorded in the second site 32. 6 during September. The reason for the decrease in pH values in the summer months is due to the increase in the percentage of carbon dioxide resulting from the increased respiration of

aquatic organisms whose activity increases with rising temperatures, the increased decomposition of organic matter by living organisms, as well as the increase in CO_2 coming from wastewater (Goldman and Horn, 1983).

High pH values in the rainy season may be due to an increase in the photosynthesis of algae and aquatic plants that draw amounts of carbon dioxide (Farghl and Samer, 2015).

Nitrogen and phosphorus are essential nutrients for the growth of algae and aquatic plants, and their high values play an important role in the occurrence of eutrophication in water (Agarwal and Rajwar, 2010). Phosphorus has an important and direct role in respiration and algal reproduction and it enters the structure of DNA, as well as metabolic processes, energy conversion and enzyme activity (Wang *et al*., 2017).

The results showed that there were significant differences between the sites, and the highest value of total nitrogen during the month of February and phosphate during the month of April (3.83, 18.90) mg/L respectively in the second site, while the lowest value recorded in the third site (1.70, 8.60) mg/L during the month of September for phosphate and during the month of November for total nitrogen. The reason for the increase in these nutrients in the second site is due to the organic materials and detergents rich in phytonutrients carried by the Medical City waste, which causes its increase within the water column (Sharma *et al*., 2021).

Silicon is one of the common elements in the earth's crust, and silicon dioxide SiO_2, known as silicate, is the common form of silicon and it is the highest concentration of other silicon compounds in most of the world's rivers (Boyd, 2020). Water-soluble silica is an essential nutrient for diatoms forming the silica wall and its decrease in surface water stops the reproduction of diatoms (Farghl and Samer, 2015).

The results indicated a high concentration of silicate in all sites (table 1). The highest rate recorded in the second site is 3.70 mg/L during the month of February while the lowest rate recorded in the third site is 1.60 mg/L during the month of May. The increase in the value of silicate in the second site may be due to the movement of water due to currents issued from the waste drainage pipes released from the Medical City, which helps to dredge the sediment, so the concentrations of the silica in the water increase (Shehata and Badr, 2010). The low concentration of silicates may be due to their consumption by diatoms at other sites and a decrease in sediment movement (Mohseni-Bandpei *et al*., 2018).

The high concentrations of TDS in the three study sites led to the presence of Water drainage stations in the second and third sites,AL-Ani et al.(2019).

Tetracycline and Levofloxacin are the antibiotics with low concentrations in the aquatic environment up to river water from untreated sewage waste, especially hospital waste, so the results showed that high concentrations of antibiotics were recorded at the second site of antibiotics; Tetracycline and Levofloxacin (65.70, 33.80) mg/L respectively during February and December, while no value was recorded at the other two sites in all months of the study (Table 1). Sharma *et al*. (2021) indicated the risks of antibiotics and their various chemical compounds on aquatic life and photosynthesis processes carried out by organisms in the aquatic environment.

The study identified 94 species (26 genera) of Bacillariophyceae Phytoplankton diatom algae belonging to tow orders; the first Centrales 20 species (5 genera) by 21% of the total diatom while the second Pennales 74 species (21 genus) by 79 % (Table 2).

The Iraqi environment is generally characterized by a high concentration of silicates in all water sources, and this is indicated by the current results (Table 1), so it was noted the high number of diagnosed diatomic algae species in all study sites (Figure 2), and this is consistent with many studies within various environments in Iraq (Al-Hassany and Al-Bayati, 2017 Al-Tammie and Al-Jumaily, 2021; Al-Saaidi, 2022).

The highest number of species was recorded in the third site while the lowest number was recorded in the second site in all seasons (Fig. 2, 3).

The second site is the most contaminated with organic compounds dumped from Medical City. This indicated by Grenni *et al.* (2018) when hospital waste released into riverbeds leads to an increase in nutrients that stimulate the growth of phytoplankton (this is consistent with the high concentrations of nutrients found in the second site (Table 1)).

However, the presence of antibiotics and drug residues causes disruption of the growth of some types of algae at the expense of other species, the blue-green algae is represented by the resistance of some types of antibiotics to high concentrations of antibiotics, unlike diatoms, which affect the presence of acceptable environmental concentrations of antibiotics in the construction of

their body structures from silica, as thus stopping reproduction and reducing the species of diatoms (Guo *et al.,* 2016). Therefore, we note a decrease in the number of species of diatoms within the second site.

The number of species recorded in each site also varied according to the seasons of the study, and the third site recorded the highest number of species was 44 species during the spring, while the same site recorded the lowest number of species 17 during the winter (Table 2).

The increase in the number of diatoms species in the fourth site is due to the presence of the movement of boats within the region. The movement of boats helps to separate the diatoms adherent to the aquatic plants within the site represented by the shanplann plant and the Nile flower, and the movement of the water stream helps to separate the diatoms attached to the boats themselves, which helps to increase the number of centric diatoms and thus increase the number of diatoms in general and algae prefers adherence to boats, and this is referred by Abdulsahib and Al-Magdamy (2022).

The reason for the decrease in the number of species during the winter may be due to the lack of movement of boats, which causes the stagnation of the river bed and its edges, and this is consistent with Al-Makdami and Al-Salman (2021) study and since the diatoms have a silica structure, they are heavy and tend to be far from the surface of the water or may be due to rainfall that helped to mitigate (Hassan *et al*., 2018).

Guo *et al*. (2016) explained the effect of antibiotics on the growth and physiology of various aquatic organisms, which included chlorophytes and diatoms. The studies pointed to the criteria that determine the growth of organisms under the conditions of increasing antibiotic concentrations in the aquatic environment and the protocols emitted in measuring the nature of the growth of organisms in the presence of these antibiotics.

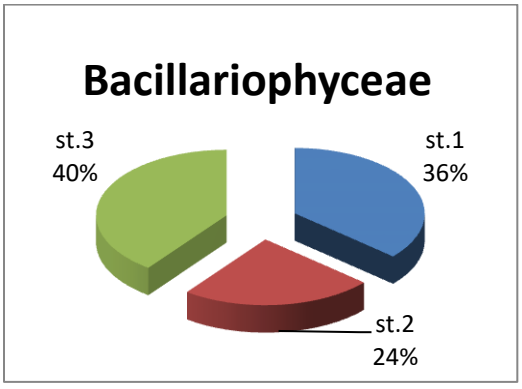

Figure (2): Percentages diatomic species diagnosed at the three sites during the seasons.

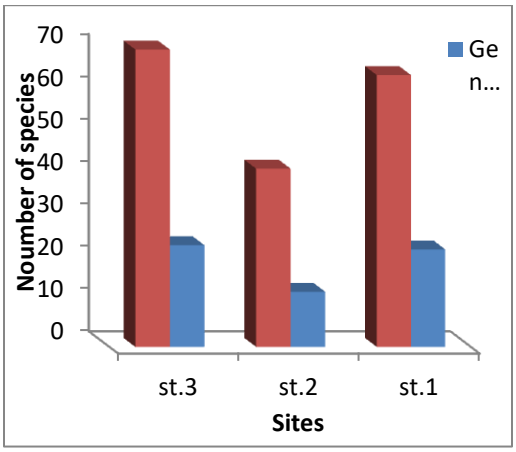

Figure (3): Numbers of species and genera of diatomic algae diagnosed at the three sites during the seasons.

Table (2): Distribution of the number of genera and species diagnosed within the seasons for all sites Sp.: Species and G: Genus.

Division \ Station	ST.1						ST.2						ST.3					
	Autumn		Winter		Spring		Autumn		Winter		Spring		Autumn		Winter		Spring	
	2022		2023				2022		2023				2022		2023			
	G	Sp.	G	Sp.	G	Sp.	G	Sp.	G	Sp.	G	Sp.	G	Sp.	G	Sp.	G	Sp.
Bacillariophceae (Centrales)	0	0	2	5	2	3	3	4	3	10	3	6	3	3	2	2	4	12
Bacillariophceae (Penales)	17	33	11	28	10	29	8	18	7	15	2	14	13	25	10	15	9	32
Total	17	33	13	33	12	32	11	22	10	25	5	20	16	28	12	17	13	44

References

Abdul Majeed, M.K.M. (2022). Evaluation of some physicochemical and biological properties of liquid waste from the Medical City compound / Baghdad and treatment with nanotechnology. MSc. Thesis. College of Education for Pure Sciences, Tikrit University. 132 pp.

Abdul sahib,Z.K.and AL-Magdamy.B.H.A .2022.The Effect of changing the culture medium on the growth curves of some Iraqi doatoms. Biochem, 22.(1): 473-478.

Agarwal AK, Rajwar GS. Physico-Chemical and microbiological study of Tehri dam reservoir, Garhwal Himalaya, India. J Am Sci. 2010;6(6):65–71.

Al-Hassany, J.S and AL Bayaty, H.E. 2017. Screening of Epiphytic Algae on the Aquatic Plant Phragmites australis inhabiting Tigris River in Al Jadria Site, Baghdad, Iraq. Bagdad Science Journal, 14(1), pp.175.

Al-Husseini, K.T.H. (2020). Quarterly habitation of the algae community in the aquatic system of the Gharraf River and its relationship with human activities. MSc. Thesis, College of Education and Pure Sciences (Ibn Al-Haitham), University of Baghdad.

Al-Magdamy, B. A.H and Al-Salman, I. M.A. (2021). Variation of non-diatomic algae in a martyr monument lake under different climate factors. IOP Conf. Series: Earth and Environmental Science 779: 012084.

AL-Magdamy ,B.A.A.H.2019.Astudy of qualitative, classification soil algae in some areas from Baghdad,Iraq.plant Archives.19.pp 1949-1952.

Al-Saeedi, H.M.2022. Study Some Bioenvironmental Indices in Lotic and Lentic in Aquatic Ecosystem within Baghdad City.Athesis.colloge of Education Ibn AL-Haytham University of Baghdad 100 pp.

Al-Tammie, A.A.N. and Al-Jumaily, I.S. 2021. Planktonic Diatoms as Bio -indicators of Water quality of Euphrates river between Saqlawiah and Amiriat Al-Fallujah-Iraq.Ramanian. Soc. Cell Biol., (25).3.pp 6766-6813.

Al-Ani, R.R; Al-Obaidy, A.M. and Hassan, F.M. 2019. Multivariate analysis foe evaluation the water quality of Tigris River within Baghdad City in Iraq. Iraqi J. Agric. Sci., 50(1), 332-341.

Alwan, A. H., Jawad, H. J., and Mohammed, J. M. An ecological Study for the non-diatoms epiphytic algae population on P. australis and C. demersum plants in Bani-Hassan River in Holly Karbala proviance. Sci J Karbala Univ. 2017;15(2)

Apha (American public health association) (2017). Standard method for Examination of water and waste water.American public health Association, 23rd ed., Washington DC, AWWA and WCPE, USA .

Aus der Beek, T.; Weber, F.A.; Bergmann, A.; Hickmann, S.; Ebert, I.; Hein, A.; Küster, A. Pharmaceuticals in the environment—Global occurrences and perspectives. *Environ. Toxicol. Chem.* **2016**, *35*, 823–835.

Boxall, A.B.A.; Fogg, L.A.; Blackwell, P.A.; Kay, P.; Pemberton, E.J.; Croxford, A. Veterinary medicines in the environment. *Rev. Environ. Contam. Toxicol.* 2004, 180, 1–91.

Boyd, C.E. Water Quality An Introduction. Third Edit. Springer; 2020. v–258.

Branchet, P.; Arpin-Pont, L.; Piram, A.; Boissery, P.; Wong-Wah-Chung, P.; Doumenq, P. Pharmaceuticals in the marine environment: What are the present challenges in their monitoring. *Sci. Total Environ.* 2021, *766*, 142644.

Choi, H.J. and Lee, S.M., 2015. Effect of the N/P ratio on biomass productivity and nutrient removal from municipal wastewater. *Bioprocess and Biosystems Engineering*, 38 (4) (2015), pp. 761-766.

Farghl A, Samer A. 2015. Phytoplankton Diversity As a Response of Water Quality in River Nile Qena, Egypt. Egypt J Phycol.16(1):1–22.

Goldman C., Horn AL. Limnology. 1983. Vol. 29, McGrow Hill international book co., New York.. 464 p.

González-Pleiter, M.; Cirés, S.; Hurtado-Gallego, J.; Leganés, F.; Fernández-Piñas, F.; Velázquez, D. 2019. Chapter 20—Ecotoxicological Assessment of Antibiotics in Freshwater Using Cyanobacteria. In *Cyanobacteria*; Mishra, A.K., Tiwari, D.N., Rai, A.N., Eds.; Academic Press: Cambridge, UK, pp. 399–417.

Gonzalez-Pleiter, M.; Gonzalo, S.; Rodea-Palomares, I.; Leganes, F.; Rosal, R.; Boltes, K.; Marco, E.; Fernandez-Pinas, F. 2013, Toxicity of five antibiotics and their mixtures towards photosynthetic aquatic organisms: Implications for environmental risk assessment. *Water Res. 47*, 2050–2064.

Guo, J.; Selby, K. and Boxall, A.B. 2016. Effects of Antibiotics on the Growth and Physiology of Chlorophytes, Cyanobacteria, and a Diatom. Arch. Environ. Contam. Toxicol. 71, 589–602.

Halling-Sørensen, B.N.N.S.; Nielsen, S.N.; Lanzky, P.F.; Ingerslev, F.; Lützhøft, H.H.; Jørgensen, S.E. Occurrence, fate, and effects of pharmaceutical

substances in the environment-A review. *Chemosphere* 1998, *36*, 357–393.

Hassan, B. A.; Ibrahim, T. M.; AL-Salman, I.M. and Ismael, A.M.(2018). Impact Ofwater Mixingareas In Qualitative Variationsof Phytoplankton Algae And Some Physiochemical characteristics Of Water On A Section Of Tigris River, Plant Archives Vol. 18 No. 2, 2477-2484 pp.

Kassim, M. and Mukai, H. (2006). Contribution of benthic and epiphytic diatoms to Clam and Oyster production in the Akkeshi-Ko estuary Journal Oceanogr; 62: 267-281.

Ibrahim, T.M.;Nayyef,R..H, and AL-Magdemy,B.A.A.H.2020.Effect of algal extracts on the the growth of tow bacterial types isIoated from pollutants discharge.Indian Journal of Forensic Medicine and Toxicology, 2020,14(1),pp.741-744.

Kümmerer**,** K. 2010, Pharmaceuticals in the Environment. *Annu. Rev. Environ. Resour. 35*, 57–75.

Liu, L.; Wu, W.; Zhang, J.; Lv, P.; Xu, L.; Yan, Y. 2018, Progress of research on the toxicology of antibiotic pollution in aquatic organisms. *Acta Ecol. Sin. 38*, 36–41.

Liu, Y.; Chen, S.; Zhang, J.; Li, X.;2017 Gao, B. Stimulation effects of ciprofloxacin and sulphamethoxazole in *Microcystis aeruginosa* and isobaric tag for relative and absolute quantitation-based screening of antibiotic targets. *Mol. Ecol. 26*, 689–701.

Mohseni-Bandpei A, Motesaddi S, Eslamizadeh M, Rafiee M, Nasseri M, Montazeri Namin M, et al. 2018. Water quality assessment of the most important dam (Latyan dam) in Tehran, Iran. Environ Sci Pollut Res.25(29):29227–39.

Mostafa, M.H. and Janghiz, M.H. (2007). The qualitative variation of two sites on the Tigris River within the city of Mosul. Mesopotamia Sciences Journal, 18(1): 111-124.

Nie, X.P.; Liu, B.Y.; Yu, H.; Liu, W.; 2013, Yang, Y. Toxic effects of erythromycin, ciprofloxacin, and sulfamethoxazole exposure to the antioxidant system in *Pseudokirchneriella subcapitata*. *Environ. Pollut. 172*, 23–32.

Pazdro, K.; Borecka, M.; Siedlewicz, G.; Biak-Bieliska, A.; Stepnowski, P. 2016, Analysis of the residues of pharmaceuticals in marine environment: State-of-the-art, analytical problems and challenges. *Curr. Anal. Chem. 12*, 202–226.

Roberts, J. (2011). Review of Drawing Lines in the Forest: Creating Wilderness Areas in the Pacific Northwest. Kevin R. Marsh. University of Washington Press. Environment and Society, 2(1), 194-196.

Salih, A. L. M., Al-Qaraghul, S. A., & Idan, R. M. (2018). Geochemical study of the Tigris river sediments in the surrounding area of Baghdad medical city. *Science and Technology*, *3*(2), 129-132

Shah, M.R.; Hossain, Y.; Begum, M.; Ahmed, Z.; Ohtomi, J.; Rahman, M.; Alam, J.; Islam, A. and Fulanda, B. (2008). Seasonal variations of phytoplankton community factors of the south west coastal water of Bangladesh. J. Fish. Aqut. Sci., 3(2):102-113.

Sharma, L.; G.Siedlewicz and K.pazdro.2021.The Toxic effects of Antibiotics on Freshwater and Marine Photosynthetic Microorganisms:State of the Art.plants.10(3).591.http$_s$//doi.org/10.3390/10030591.

Sharma, M., Thukral, N., Soni, N. and Maj, S. (2016). Microalgae as Future Fuel: Real Opportunities and Challenges. Journal of Thermodynamics and Catalysis. 6, 139.

Shehata SA, Badr SA. 2010. Water quality changes in River Nile Cairo, Egypt. J Appl Sci Res.6(9):1457–65.

Siedlewicz, G.; Białk-Bielińska, A.; Borecka, M.;2018 Winogradow, A.; Stepnowski, P.; Pazdro, K. Presence, concentrations and risk assessment of selected antibiotic residues in sediments and near-bottom waters collected from the Polish coastal zone in the southern Baltic Sea—Summary of 3 years of studies. *Mar. Pollut. Bull129*, 787–801.

Salman, B.M.; AL-khafaji, R.MN. and Mahdi, B.A.K. 2022. Assessment of the physio chemical properties and hydro chemical formula of Water in some wells south of Baghdad in 2020.Eco.Env &cons.28(January Suppl Issue).p 11-20.

Van Dolah, R. F. ; Jutte, P .C.; Riekerk, G. H. M.;Levisen, M. V .;Zimmerman, L .E.; Jones, J. D.; Lewitus. A. J.; Chestnut, D.EMcdermott, W.; Bearden, D.; Scott GI and FMP. The condition of South Carolina's Estuarine and coastal habitats during 1999-2002. 2002. p. 132.

Wahhab, T. A. and Hassan, F. M. (2023). Environmental parameters drive the phytoplankton community structure: a case study in Baghdad Tourist Island Lake, Iraq. Ibn Al-Haitham Journal for Pure and Applied Sciences. 36(1):74-87pp.

Wang L, Wang X, Jin X, Xu J, Zhang H, Yu J,2017 et al. Analysis of algae growth mechanism and water

bloom prediction under the effect of multi-affecting factor. Saudi J Biol Sci [Internet]. 24(3):556–62. Available from: 128 http://dx.doi.org/10.1016/j.sjbs.2017.01.026

Wang, Z.; Chen, Q.; Hu, L.; Wang, M.2018. Combined effects of binary antibiotic mixture on growth, microcystin production, and extracellular release of *Microcystis aeruginosa*: Application of response surface methodology. *Environ. Sci. Pollut. Res. 25*, 736–748.

Wang, Z.; Chen, Q.; Zhang, J.; Dong, J.; Ao, Y.; Wang, M.; Wang, X.2019. Long-term exposure to antibiotic mixtures favors microcystin synthesis and release in *Microcystis aeruginosa* with different morphologies. *Chemosphere* , *235*, 344–353.

Wehr, J.D. and Sheath, R.G., 2003. Freshwater Algae of North America: Ecology and Classification. Academic Press, 918 pp.

Weiner , E.D. (2000). Application of environmental chemistry. Lewis Publishers, London, New York.