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RESEARCH ARTICLE

Environmental and Identification Study of Algae Present in Three Drinking Water Plants located on Tigris River in Baghdad

*** Ibrahim J. Abed[1*], Ahmed Aidan Al- Hussieny[2], Roeda F. Kamel[2] and Abdul latif. M. Jawad[1].**

1. Department of Biology, College of Science, University of Baghdad, Baghdad-Al-Jadiria, Iraq..

2. Center and Department Water research and Directorate of water Treatment, Technology and Ministry of Science and Technology.

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Corresponding Author

Ibrahim J. Abed
ibrahimabed95@scbaghdad.edu.iq

Abstract

Planktonic algae dominate the surface of standing waters where light is bright enough for them to produce food by photosynthesis. from September 2011 to August 2012, samples of water were taken monthly from three drinking water treatment stations located on Tigris River in Baghdad City at three sites included river intake, sedimentation tank and walls of sedimentation tank.

Seven species of blue-greens were isolated from the river intake of the studied stations which belonged to four cyanobacterial orders: Oscillatoriales, Chroococales, Stigonematales and Nostocales. These genera were dominated in three stations in most of the study period. There were varied results as to the dominancy of algae according to samples collection sites. A total of 268 algal taxa were identified, 161 taxa belonged to Bacillariophyceae (diatoms), 58 taxa to chlorophyceae and 49 taxa to cyanophyceae. The total count of attached cyanophaceae was the hgihest compard with Bacilariophyceae, while total count of cyanophyceae in sedimentation tank was the lowest.

Introduction

Planktonic algae dominate the surface of standing waters where light is bright enough for them to produce food by photosynthesis. The planktonic algae community is typically composed of green algae, blue-green algae, diatoms, and euglenas forming bloom that depend on lake trophic status and these blooms are considered desirable as the beginning of the food chain.. Many species of algae are involved in algae blooms and these species change over time based on temperature, light, nutrients, and other factors (Pfandl et al., 2009).

Benthic algae occur at the bottom of the water column in lakes and rivers, and are directly associated with sediments including rocks, mud and organic debris (Al-Dulaimi, 2006). They were frequently present in mixed biofilms (with bacteria, fungi and invertebrates). Under high light conditions, the biofilm may become dominated by extensive growths of filamentous algae forming a periphyton community. Attached algae may also be fixed to living organisms as epiphytes including higher plants, larger attached algae and large planktonic colonial algae. (Bellinger and Sigee, 2010).

Over the past three decades, the frequency and global distribution of toxic cyanobacterial incidents reveales to have increased might be related to the global climate changes (Neilan et al., 2013). Cyanobacteria will dominate phytoplankton communities, for several reasons (Paerl and Huisman, 2009), first, high atmospheric CO2 content will result in higher rates of photosynthesis. This carbonate source can change the pH of water, allowing more tolerant cyanobacteria to out-compete other phytoplankton. Second, as water temperature increases, phytoplankton growth rate increases. While eukaryotic primary producers' growth rates begin to decline when water temperature reaches 25˚ C, cyanobacterial growth rates remain high. Finally, with unknown weather patterns associated with climate change, droughts that increase salinity of waters can encourage growth of salt-tolerant cyanobacteria (Stewart, 2011).

The Tigris River is one of two main sources of drinking water for Iraq, serving population approximately seven million people settled in Baghdad city, this river usually affected by agricultural and industrial eutrification and the sewage effluents, which provide suitable environment for cyanobacterial growth.

Materials and Methods

1. Study Area and Sampling

During the September from year 2011 to 2012 ,samples were collected monthly from three drinking water treatment stations included Sharek Dijla (1) Al-Wathba (2), and Al-Rasheed (3) stations in Baghdad City that are represent three sites located on the Tigris River included northern, mid and southern of city.

Samples were collected from the higher superficial layer 20-30cm deep from intake of river and sedimentation tank in the amount of two samples, one of them for isolation and other for algal identification while attached algal (periphyton) samples were collected from the walls of sedimentation tanks. Collection method was performed using a 20µ mesh net. Samples were transported immediately to the lab and incubated under controlled conditions for algal growth (200) $\mu E/m^2/s$ and 26± 2 C˚. Attached algal samples were prepared by selection an area 20×20 cm on walls of sedimentation tank.

2. Media and Culture Conditions

Different plating techniques as spread and streak method were carried out to purify the culture. A single colony formed on the surface of the agar plate was picked up and transferred to new plate. After several transfers, the single colony was inoculated into the liquid medium. For cultivation of cyanobacteria. 10 ml of water sample were inoculated in 50 ml sterilized standard BG-11 medium with and without nitrate nitrogen in 100 ml Erlenmeyer flasks in triplicates. The flasks were shaken well and incubated in growth room. Culturing was carried out with proper light (50 – 75 µE m-2 S-1) and incubation temperature (24ºC).

3. Morphological Studies

Pure culture was observed under microscope. The cell shape and size were observed, measured by micrometry and documented as microphotograph. Identification of specimens was carried out using the taxonomic publications (Desikachary, 1959; Prescott, 1964; Prescott, 1978; Prescott, 1982; Hustedt, 1930; Hustedt, 1959).

4. Quantitative Study

Total number count of Phytoplankton and periphyton was performed by use sedimentation method (Furet and Benson, 1982).

5. Physio-Chemical Parameters

Temperature, Electrical Conductivity, pH, Turbidity, Calcium, Magnesium, Nutrients which included Dissolved Nitrate,Dissolved Nitrite and Reactive Dissolved Silicate were measured on water samples were taken from studied stations.

6. Statistical Analysis

The statistical programmed SPSS version twenty was used to analysis the effect of difference factors in this study. Mean and standard error values were calculated. ANOVA table was employed to study the effect of Physio-chemical parameters on count of cyanophyceae in studied stations.

Results and Discussion

Seven species were isolated from the river intake of the studied stations which were: *Microcystis aeruginosa*, *Microcystis flos-aquqae*, *Lyngbya sp*., *Chroococcus turigidus*, *Westiellopsis prolifica*, *Oscillatoria limnetica* and *Nostoc carneum* which belonged to four cyanobacterial orders: Oscillatoriales, Chroococales, Stigonematales and Nostocales. These species were identified as dominant in the studied stations as shown in Figure 1.

The dominant cyanobacterial genera in all studied stations in most of the study period were: *Lyngbya spp*., *Oscillatoria spp*., *Microcystis spp*., *Westiellopsis sp.* , *Nostoc spp*. , *Chroococcus spp*. These taxa were observed in all studied stations in most sites of samples collection{river intake, sedimentation tanks and walls of sedimentation tanks}while the genera *Phorimidium spp*., *Tetradesmus spp*.,*Gloeocapsa spp.*, *Aphanocapsa spp*., *Haematococcus spp*. were varied in their presence during study peroid. However, *Lyngbya spp*. and *Oscillatoria spp*.
Were observed present in all studied stations and in most study period compared with other cyanobacterial isolates.

The dominant species of Bacillariophyceae which identified in all studied stations and most periods of study were: *Melosira granulate*, *Cyclotella meneghiniana*, *Cymbella affinis*, *Nitzschia palea*, *Syndra ulna*, *Diatoma vulgare*, *Cocconies placentula*, *Cocconeis pediculus* , *Cyclotella ocellata*, and these findings agreed with the study of Al-Janabi, (2011).

The dominant genera of Chlorophyceae in most of study peroid were: *Pediastrum spp.*, *Chlamydomonas spp.* , *Chlorella spp.*, *Mougeotia spp.*, *Scenedesmus spp. and Monorephidum spp.*, while the genera *Pandorina spp.*was observed in station (1) during October and November at all sites of collected samples.

Bacillariophyceae group were dominant according to the total number of taxa(diversity) in all stations, the second group of dominant algae was Chlorophyceae follwoed by cyanophyceae. Interestingly, this dominancy agreed with many studies on the Iraqi aquatic ecosystems which done by Huq et al., 1977; Huq et al.,1978; Saad and Antoine 1978; Saadala, 1988; Al-Temimi, 2006; Al-Sarraf, 2006 and Farkha, 2006,Dwaish, 2012; Al-ganabi, 2011 but it does not agreed with these studies when compared with the total cell count which showed that dominancy was to Bacillariophyceae group while the second group was cyanophyceae follwoed by Chlorophyceae. Differences in the results with others might be belongs to the variations in the climate of Iraq which related to the increase of temperature through passed ten years compared with the temperature recorded on last decades, in addition to the increase of pollutants (agricultural runoff , industrial and sewage effluents) that discharged in the river. These factors provide protected mesocosms of cyanobacteria growth and play a main role in their dominancy.

The total count of Phytoplankton in stations measured during this study for river intakes, sedimentation tanks and attached algae were varied (Figure 2). The total cell count of attached Cyanophyceae was the highest (32.087 cell x 10^4/l) compared with attached Bacillariophyceae and Chlorophytceae were 16.7cell x 10^4/l and 5 cell x 10^4/l respectively. The total count of Bacillariophyceae was the highest in river intake (7.6 cell x 10^4/l) and sedimentation tank (3.3 cell x 10^4/l) in studied stations. Usually the dominancy was for Bacillariophyceae (Diatoms), but these results suggest that the dominancy of algae could be changed from site to another. The attached Cyanophytceae showed higher total count in station 2 (32.087 cell x 10^4/l) in comparison with other stations whereas the total count of river intake and sedimentation tank have higher count in station 3 (1.9 cell x 10^4/l and 1.6 cell x 10^4/l) respectively.

The results might be related to the highly pollutants which dischrged in river stretch where these stations locate, or might be due to the acquisition of cyanphyceae to mucelagenous sheath which contributed to increase the adhesive capability of these organisms,in addition to their secreting of some compounds showed antimicrobial (anti diatomic, antifungal and antibacterial) activities (Abed et al. 2011) or these organisms have strong adhesive strength represented by secreting visco-elastic materials (Callow and Callow, 2002), all these might be enable these organisms to out-compete the other groups of algae to make the biofilm. But in Station 1,the total count of attached Bacilariophyceae was hgiher compared with attached cyanophaceae might be due to the low pollutants which discharged in this region where station 1 located because of limited industerial and energy plants compared with other stations.

The results revealed that some physio-chemical parameters of water have significant positive correlation with the total cell count of cyanobacteria in studied stations (Table 1).

It was found there significant differences between temperature of water and total cell count of cyanobacteria (($P \leq 0.001$) in all stations. Also, turbidity had significant differences with total cell count of cyanobacteria in stations 1, 2 ($P \leq 0.05$) and station 3($P \leq 0.001$).While no significant effects of pH, conductivity, Ca^{+2}, $NO_{2,}$ NO_3 and silicate were observed with total cell count of cyanobacteria.

In conclusion, there were seven dominant toxigenic cyanobacterial species were isolated from the studied station and the dominancy and total count of algae were varied according to samples collection sites.physiochemical parameters varied in their effect according to the studied station.

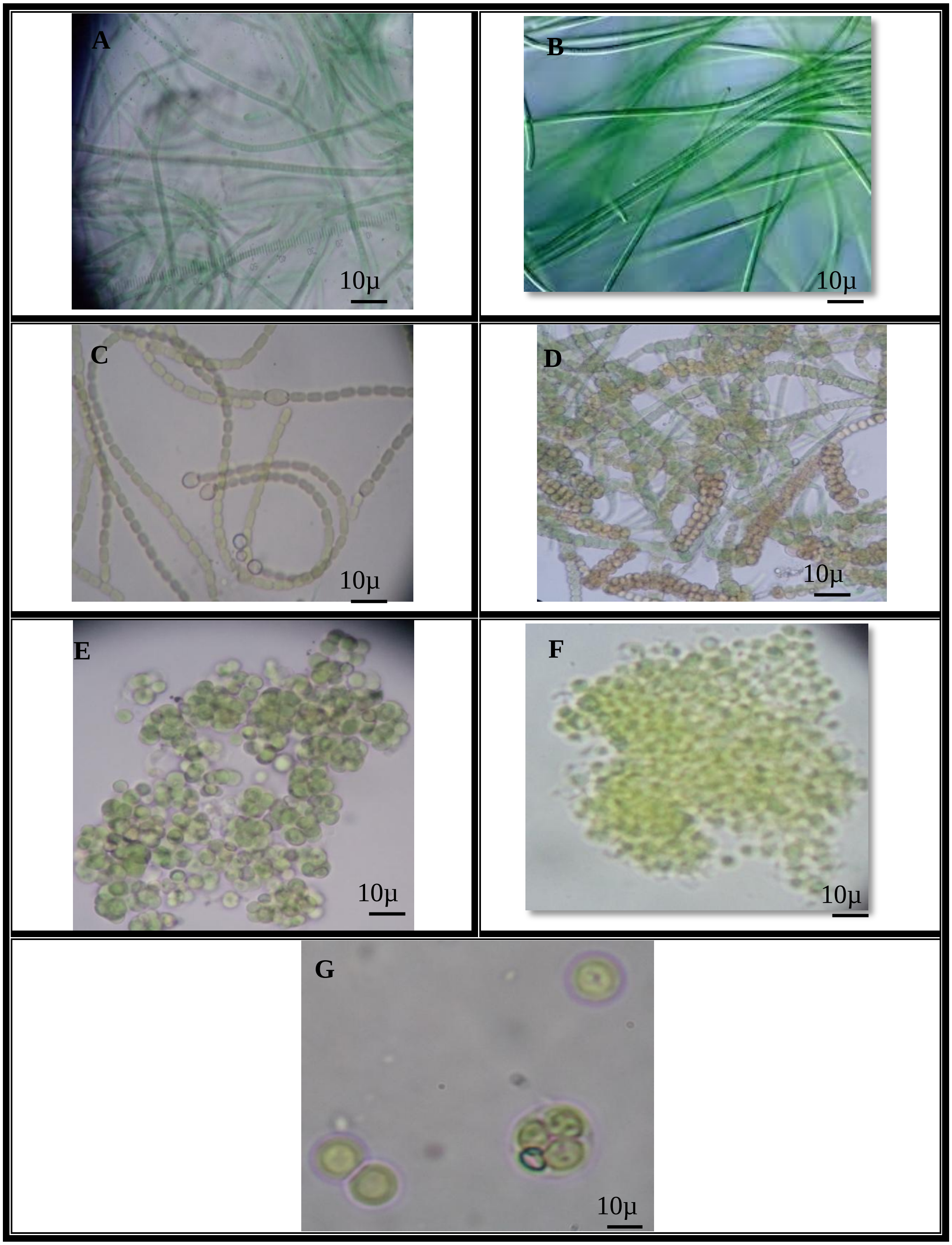

Figure 1. Photomicrographs of some dominant cyanobacteria isolated from three stations on Tigris River. A: *Lyngbya sp*., B: *Oscillatoria limnetica*, C: *Nostoc carneum*, D: *Westiellopsis prolifica*, E: *Microcystis flos-aquae*, F: *M. aeruginosa* G: *Chroococcus turigidus.*

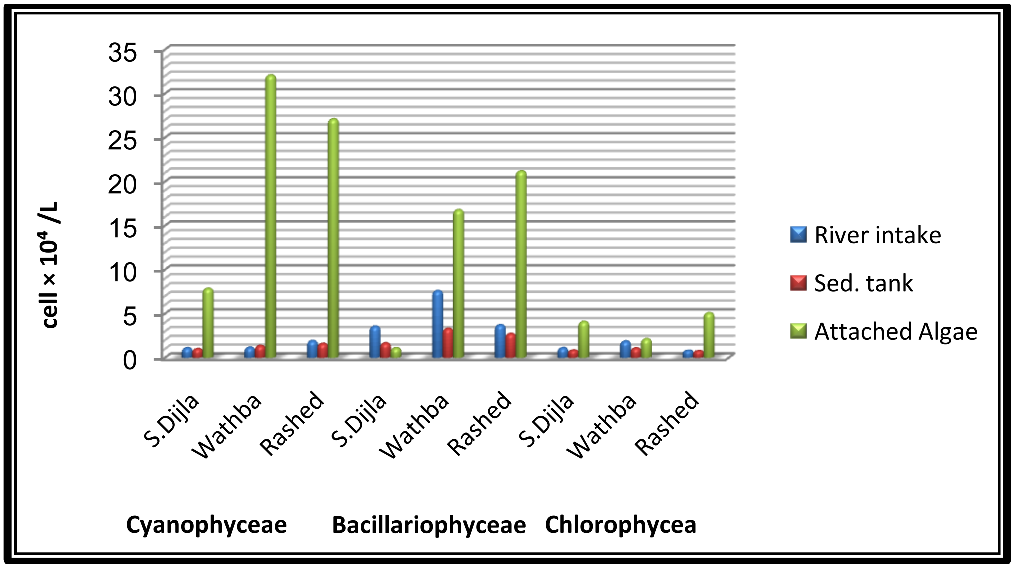

Figure 2. Total cell count of all algal groups in studied stations sites.

Table 1: Statistical analysis for the effect of physiochemical parameters on cyanobacterial total cell of count in studied stations.

Parameters	Stations F-test		
	S. Dijla	**Al-Wathba**	**Al-Rasheed**
Temperature	9.55**	4.93*	13.31**
Turbidity	25.42**	7.36*	4.97*
pH	0.90	3.67	0.39
Conductivity	5.60	0.36	1.44
Ca^{++}	0.77	0.74	2.87
Mg^{++}	1.14	9.52**	2.82
NO2	1.14	1.25	1.34
NO3	0.37	0.44	0.80
Silicate	0.31	1.61	0.78

* $p \leq 0.05$ ** $p \leq 0.001$

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