DJS Vol. 46(2023) –pp.77- 97 ISSN: 1012-5965

Delta Journal of Science

Available online at **https://djs.journals.ekb.eg/**

Research Article **Microbiology**

Chemical and Phytoplankton profile of two water plants model before and after treatment in Menoufia governorate, Egypt

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Received: 12/2/2023 **Accepted**: 5/3/2023

KEY WORDS

Surface water,

water Plant,

Turbidity,

algal count

ABSTRACT

Safe drinking water is a necessity for the health and welfare of a community. This study was carried out to compare between certain physicochemical parameters and phytoplankton of two water treatment plants (Shebin El-kom conventional plant and Shobrabass compact water plant) during a period from February 2019 to December 2019. The treated water at these plants had a remarkable enhancement as compared with the raw one basically with the values of TDS, conductivity, total alkalinity, phosphates, and nitrates but the treated water of Shobrabass plant has high turbidity ranged from 1.6 NTU to 3 NTU compared with Shebin El-kom that ranged from 0.18 NTU to 0.33 NTU. Regarding biotic component, algae disappeared more or less completely at the end of the treatment process. The results showed diverse phytoplankton structures belonging to three groups: Bacillariophyta, Chlorophyta, and Cyanophyta. Bacillariophyta represented the most widespread group in Shebin El- kom and Shobrabass raw water during the period of study as it accounted 72.6% and72.7% of the total annual crop, respectively, followed by Chlorophyta with 17.4% and 15.5%, respectively and Cyanophyta ranked as 3rd group with 11.6% and 11.5% of the total annual crop for Shebin El-kom raw water and Shobrabass raw water, respectively. The conventional Shebin El-kom water plant was more effective than Shobrabas compact water plant obtaining better potable water, and so a modification was performed on Shobrabas. The final turbidity results decreased from 2.3 NTU to 1.4 NTU and the total algal count decreased from (1000×10^3 organisms/L) to (26×10^3 organisms/L).

Introduction

River Nile is considered the main Egyptian water source for the domestic, industrial, and irrigation uses. The increase in population and urbanization is a big challenge to the country in facing water scarcity. Water resources are subject to pollution mainly due to the discharge of solid and liquid waste represented in leachate, domestic and industrial wastewaters **(Bouita *et al.,* 2021).** About 20% of the world's population lacks safe drinking water, and almost half the world population lacks suitable sanitation. Consequently, potable water has to be colorless, tasteless, odorless and free from any micro-organisms. This process involves removing the contaminants using physical processes such as settling and filtration, chemical processes such as coagulation and disinfection; biological processes such as rapid and slow filtration of sand **(Galal, 1989).**

Chemical and physical analysis is important as it related to the hygienic testing of a water supply **(Abo-amer *et al.,* 2008).** An appropriate assessment of the appropriateness of water requires the concentrations of some important parameters such turbidity, conductivity, total dissolved salts (TDS), pH, Ca^{2+}, Mg^{2+}, K^{+}, Na^{+}, Cl^{-}, HCO^{3-}, $SO4^{2-}$, F^{-}, NO^{3-}, $PO4^{3-}$, and comparing with the guideline values set for potable water. The phytoplankton was treated as indicators of water quality, as some species result in noxious blooms; sometimes develop offensive tastes and odors or toxic conditions that may lead to in animal death or human illness. Although many species of freshwater algae multiply quite intensively in water, they do not concentrate to form dense surface blooms of remarkably high cell density, as do some cyanobacteria. The toxins that freshwater algae may have are therefore not accumulated to concentrations likely to become risky to human health **(Chorus and Fastner, 2001).** Chlorine is widely used as a disinfectant at water treatment plants, but its concentrations did not kill some protozoan organisms and their cysts **(Wallis *et al.*, 1996; Liberti *et al.*, 2002).** Moreover, it was reported that an overdose of oxidizing substances should be avoided because it can cause damage to algal cells and release harmful toxins or offensive taste and odor-related compounds or water-color in case of an overdose **(Shen *et al*., 2011; Yanxia Zhao *et al.,* 2021).**

Conventional water treatment plant has a series of treatment processes such as coagulation, flocculation and clarification through sedimentation, filtration and disinfection; remove enough quantity of algal toxins by removing the intact algal cell **(Loper, 1989)**. Toxins are secondary metabolites which are largely contained in the algal cell and transport to water during lyses or damage of the cell. Direct filtration is considered as a conventional plant without clarifiers **(Galal *et al.*, 2017)**.

Compact water treatment plant is a type of treatment which is carried out through coagulation (via coagulant alum), filtration in a closed container with sandy media in the ground of the filter and disinfection through chlorine. Therefore, this study aims to:

1) Compare between certain physico chemical parameters and phytoplankton before and after treatment in two water plants in Menoufia Governorate, Egypt. These plants apply different water treatment methods as mentioned previously.

2) Applying a modification on the compact water plant to improve the treatment process and monitoring the algal community, the physiochemical parameters and algal count of water before and after treatment.

Materials and methods

Sampling

Water samples were collected from two different sites, surface water plants in Shebin El-kom and Shobrabas in El-Menoufia, Egypt. The sampling cruises were done monthly during (winter, spring and summer, 2019) from the studied sites. All water samples were assembled according to standards mentioned in (APHA, 1998). Samples were preserved directly after collection by acidifying with concentrated HNO_3 to pH<2 by adding 5 ml nitric acid to 1 liter water samples and preserved in refrigerator according to standard method 20th edition. All the experiments were done in (El-Bahary water plant lab in Shebin El-kom city, Menoufia).

Physicochemical parameters

Collected water samples were preserved immediately by acidifying with conc HNO_3 to pH<2 by adding 5 ml nitric acid to 1000 ml water sample then preserved in the refrigerator. Physicochemical parameters were estimated according to standard methods for the examination of water and wastewater 22nd edition. pH value was measured by a digital pH meter (Metrohm827 PH lab). Total dissolved salts and Conductivity were measured directly by using a digital meter (Conductivity meter selecta). Total hardness was measured by titration method against EDTA **(Olmsted and Williams, 1997)**. Calcium hardness was measured by EDTA titrimetric method **(APHA, 2010)**. Turbidity was measured using a digital turbidity meter (WTW Turb550). Alkalinity was estimated using titration against 0.02N sulfuric acid **(APHA, 2010)**. Chlorides were titrated against $AgNO_3$ **(Kolthoff and Stenger, 1947).** Iron was estimated by the phenanthroline method **(Duncan, 1979)**. Manganese was determined with the persulfate method **(Mills, 1950)**. Sulfate was estimated by the turbid metric method **(Thomas and Cotton, 1954).** Nitrate was determined by UV spectrophotometric screening method **(Navone, 1964)**. Phosphate was estimated by the stannous chloride method **(Strickland and Parsons, 1965)**. Ammonia was measured by the Nessler method (Standard method 19th edition).

Phytoplankton examination

For examination of phytoplankton, samples were collected in 1000 ml liter glass containers and preserved with standard Lugol's Iodine solution **(APHA, 2010)** then filtered using membrane filtration (Sartorius SM 16828) then centrifuged at 2000 g for 10 min using (MPW–350e centrifuge). Algae were counted through standard microscope through Sedgwick Rafter cell which is a slide with 1 mm, of 1,000 mm^2 area and volume of 1.0 ml. One ml of concentrated sample was pipetted on Rafter slide and examined under bincolor microscope **(Lund *et al*., 1958)** and algal species was identified according to **(Bourrelly, 1968; Prescott, 1982; Starmach, 1984; Tikkanen, 1986; Popovsky and Pfiester, 1990; Compère, 1991; Krammer and Bertalot, 1991).**

Water Treatment and plant modification

Different problems were detected in the design of Shobrabas water plant therefore a modified approaches were applied for enhancing the removal of algae and decreasing turbidity and the microbial effect by:

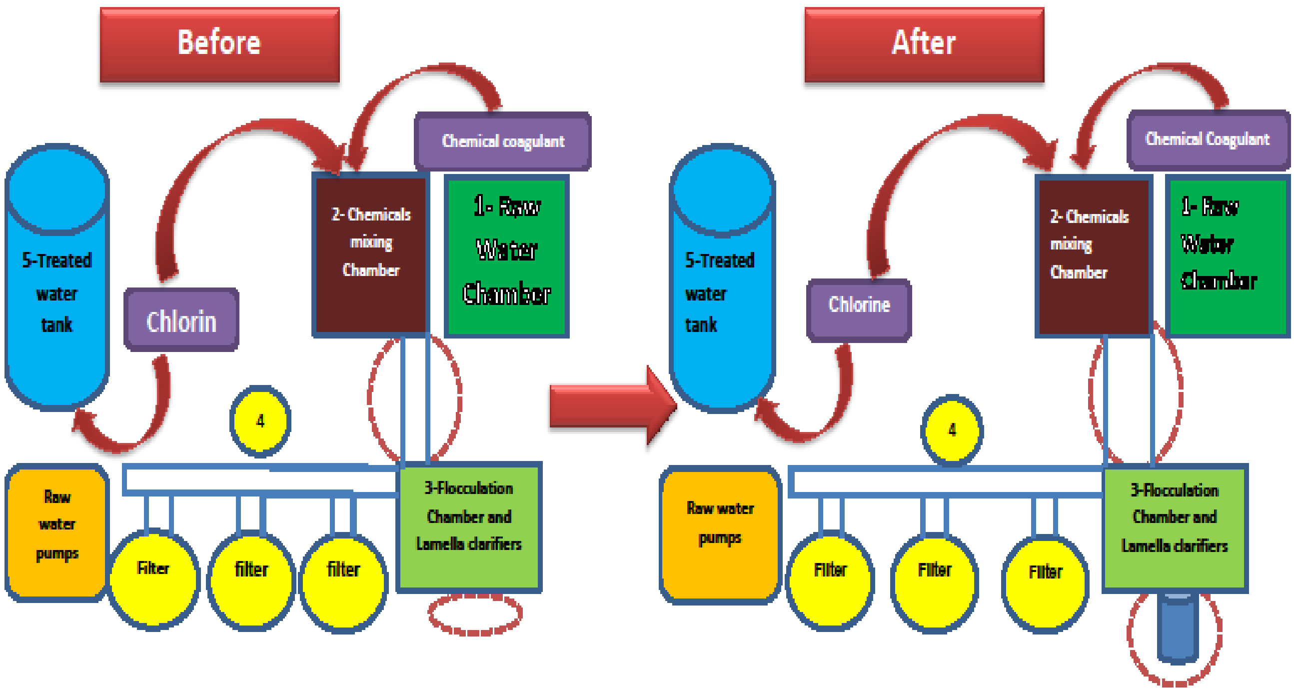
1- Increasing the diameter of the tube that connect the mixing chemicals with raw water chamber to the flocculation chamber which lead to increasing the contact period with chemicals to enhance the efficiency of the water treatment.

2- Adding controlling valve under the flocculation chamber to facilitate the withdrawing of the sludge twice daily every 12 hours that will decrease the turbidity and the total algal count as shown in Fig. (1) **(Galal *et al*., 2017).**

Results

Physicochemical parameters

As shown in Table (1), turbidity ranged from 0.18 to 11.2 NTU in Shebin El-kom plant while in Shobrabas plant, it ranged from 1.6 to 12.7 NTU. The pH range of Shebin El-Kom was 7.1 to 8 while in Shobrabas, was 7.5 to 8.2. Shebin El-Kom plant's water temperature ranged from 19°C to 30.1°C while in Shobrabas plant, ranged from 18.8°C to 29.2°C. TDS and conductivity range was 222 to 363 ppm, 355 to 580µS/cm, respectively in Shebin El-kom plant while, in Shobrabas plant was 225 to 280 ppm, 360 to 448 µS /cm, respectively. Magnesium hardness range was from 55 to 94 ppm in Shebin El-Kom while in Shobrabas, was 20 to 90 ppm. Magnesium ions concentration range was 13.1 to 22.6 ppm in Shebin El-Kom while in Shobrabas, was 4.8 to 21.5 ppm. Manganese in Shebin El-Kom range was <0.01 to 0.18 ppm while in Shobrabas was 0.01 to 0.2 ppm. Iron range was <0.01 to 0.3 ppm in Shebin El-Kom while in Shobrabas was 0.01 to 0.22 ppm. Phosphate range was from <0.01 to 0.11 ppm in Shebin El-Kom while in Shobrabas, it was from 0.21 to 0.66 ppm. Ammonia in Shebin El-Kom ranged from <0.01 to 0.41 ppm, while in Shobrabas ranged from 0.01 to 0.43 ppm. The range of Shebin El-Kom's nitrate was from 0.07 to 0.62 ppm while in Shobrabas ranged from 0.2 to 0.55 ppm. At last, Sulfate range in Shebin El-Kom was from 27 to 59 ppm while in Shobrabas, was from 21 to 48 ppm.



Notes	solution	Reason	Problem
Pipe diameter was 4cm and after modification became 6cm.	1- Increasing the diameter of the tube that connect the mixing chemicals with raw water chamber to the flocculation chamber which lead to increasing the contact period with chemicals to enhance the efficiency of the water treatment.	1-The high speed of water flow in flocculation chamber leading to short contact time with chemicals causing high turbidity and high algal count.	1-High turbidity of treated water
	2- Adding controlling valve under the flocculation chamber to facilitate sludge withdrawing twice daily (every 12 hours) that will decrease the turbidity and the total algal count.	2-Daily sludge withdrawal become difficult due to absence of controlling valve under flocculation chamber	2- High algal count of treated water

Fig. (1): Shobrabas water plant before and after modification

Table (1): The physicochemical parameters of Shebin El-Kom and Shobrabas surface raw and treated water during the period of investigation

Month	February				April				June				August				October				December			
Water Plant / Parameter	S		C		S		C		S		C		S		C		S		C		S		C	
Sample	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T
Temperature°C	22	22.3	20.5	20	22.6	21.9	22.2	22	30	30.1	28.5	28	27.9	27.8	29.2	28.8	24	24.3	24.1	23.8	19	19.1	18.8	19
Turbidity(NTU)	7.5	0.33	10.8	2.19	11	0.28	10	1.6	10	0.3	11	2	10.8	0.18	12	3	11.2	0.4	12.7	2.4	7.9	0.25	10.9	2.5
pH	7.7	7.4	7.8	7.5	7.7	7.2	7.9	7.6	7.8	7.5	8	7.7	8	7.6	8.2	7.9	7.7	7.3	7.9	7.6	7.5	7.1	7.8	7.5
TDS(mg/L)	360	363	238	241	255	260	226	230	222	227	234	238	245	249	225	228	310	315	272	280	350	356	271	274
(µS/Cm)Conductivity	576	580	380	385	408	416	361	368	355	363	374	380	392	398	360	364	496	504	435	448	560	569	433	438
Iron(mg/L)	0.3	0.01<	0.18	0.17	0.01<	0.01<	0.01	0.18	0.01<	0.01<	0.01	0.2	0.18	0.01<	0.01	0.1	0.2	0.01<	0.13	0.21	0.05	0.01<	0.11	0.22
Manganese(mg/L)	0.06	0.01	0.01	0.19	0.18	0.12	0.01	0.01	0.01<	0.01<	0.13	0.01	0.1	0.01<	0.01	0.01	0.02	0.01<	0.14	0.12	0.13	0.05	0.01	0.2
Total hardness(mg/L)	150	160	150	145	160	170	160	154	140	152	170	165	155	162	164	160	150	161	170	168	162	154	140	144
Ca. hardness(mg/L)	80	80	90	110	70	76	80	80	85	80	90	90	100	105	80	70	80	90	90	100	95	82	120	105
Mg. hardness(mg/L)	70	80	60	35	90	94	80	74	55	72	80	75	55	57	84	90	70	81	80	68	67	72	20	39
Ca^{+2}(mg/L)	32	32	36	44	28	30.4	32	32	34	32	36	36	40	42	32	28	32	36	36	40	38	32.8	48	42
Mg^{+2}(mg/L)	16.8	19.2	14.4	8.4	21.6	22.6	19.2	17.8	13.2	17.3	19.1	18	13.1	13.7	20.2	21.5	16.8	19.4	19.2	16.3	16.08	17.4	4.8	9.4
Total Alkalinity(mg/L)	152	130	154	150	160	150	154	160	164	152	170	154	160	140	178	140	195	188	166	160	180	170	190	176
Chlorides(mg/L)	35	40	35	40	40	44	21	33	35	40	25	35	40	45	23	30	32	40	29	40	25	30	33	42
Sulfate(mg/L)	50	59	40	48	37	45	21	29	31	34	35	45	27	35	30	40	40	49	37	44	42	48	28	36
Phosphate(mg/L)	0.06	0.01	0.37	0.43	0.11	0.01<	0.21	0.26	0.06	0.01<	0.33	0.38	0.01	0.01<	0.41	0.58	0.01<	0.01<	0.54	0.66	0.02	0.01	0.36	0.55
Nitrate(mg/L)	0.45	0.36	0.22	0.2	0.12	0.07	0.35	0.29	0.62	0.55	0.55	0.22	0.38	0.32	0.43	0.31	0.4	0.34	0.52	0.3	0.6	0.42	0.44	0.35
Ammonia(mg/L)	0.4	0.01<	0.22	0.2	0.38	0.01	0.17	0.01	0.41	0.01<	0.39	0.21	0.29	0.01<	0.35	0.15	0.31	0.01	0.39	0.29	0.13	0.01<	0.43	0.37

S: Shebin El-kom surface water plant, **Ca. hardness**: Calcium hardness, **Mg. hardness**: Magnesium hardness, **C**: Shobrabas surface water plant

Sample	RS		TS		RC		TC		P-value
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Temperature (C)	24.25	4.04	24.25	4.07	23.88	4.24	23.60	4.08	P1=0.88 P2= 0.79 P3=1.00 P4=0.91
(NTU)Turbidity	9.73	1.63	0.29	0.07	11.23	0.96	2.28	0.48	P1=0.02* P2=0.02* P3=0.00** P4=0.00**
pH	7.73	0.16	7.35	0.19	7.93	0.15	7.63	0.15	P1=0.047* P2=0.007* P3=0.001* P4=0.005*
(mg/L) TDS	290.33	57.92	295.00	57.81	244.33	21.60	248.50	22.68	P1=0.08 P2=0.08 P3=0.85 P4=0.87
Conductivity(µS/Cm)	464.50	92.72	471.67	92.29	390.50	34.55	397.17	36.45	P1=0.08 P2=0.08 P3=0.86 P4=0.87
(mg/L) Iron	0.12	0.12	0.00	0.00	0.08	0.07	0.18	0.04	P1=0.29 P2=0.001* P3=0.011 P4=0.025*
Manganese (mg/L)	0.08	0.07	0.03	0.05	0.05	0.06	0.09	0.09	P1=0.47 P2=0.15 P3=0.22 P4=0.0.35
(mg/L) Total hardness	152.83	8.01	159.83	6.40	159.00	11.92	156.00	10.10	P1=0.27 P2=0.49 P3=0.21 P4=0.58
(mg/L) Ca. hardness	85.00	10.95	85.50	10.62	91.67	14.72	92.50	15.41	P1=0.39 P2=0.37 P3=0.95 P4=0.91
(mg/L) Mg. hardness	67.83	12.89	76.00	12.31	67.33	24.71	63.50	21.81	P1=0.96 P2=0.26 P3=0.46 P4=0.73
Ca^{2+}(mg/L)	34.00	4.38	34.20	4.25	36.67	5.89	37.00	6.16	P1=0.39 P2=.37 P3=0.95 P4=0.91
Mg^{2+} (mg/L)	16.26	3.11	18.27	2.95	16.15	5.93	15.23	5.20	P1=0.97 P2=0.26 P3=0.45 P4=0.73
(mg/L) Total Alkalinity	168.50	15.95	155.00	20.97	168.67	14.01	156.67	12.04	P1=0.99 P2=0.86 P3=0.16 P4=0.21
(mg/L) Chlorides	34.50	5.61	39.83	5.31	27.67	5.61	36.67	4.72	P1=0.038* P2=0.31 P3=0.09 P4=0.008*
(mg/L) Sulphate	37.83	8.18	45.00	9.40	31.83	6.91	40.33	6.95	P1=0.21 P2=0.32 P3=0.13 P4=0.08
(mg/L) Phosphate	0.04	0.04	0.00	0.01	0.37	0.11	0.48	0.15	P1=0.00** P2=0.00** P3=0.47 P4=0.06
(mg/L) Nitrate	0.43	0.18	0.34	0.16	0.42	0.12	0.28	0.06	P1=0.90 P2=0.42 P3=0.29 P4=0.36
(mg/L) Ammonia	0.32	0.11	0.00	0.01	0.33	0.11	0.21	0.12	P1=0.93 P2=0.002* P3=0.00** P4=0.04*

Seasonal Distribution of Phytoplankton

Raw water of Shebin El-kom water plant and Shobrabas water plant

As shown in Table (4) and represented in Fig. (2), the phytoplankton populations encountered in Shebin El-kom plant are included in the groups Bacillariophyta, Chlorophyta and Cyanophyta. Bacillariophyta dominated the whole populations, as it represented for 72.6 % of total annual crop of Shebin El-kom but for Shobrabas plant it represented for 72.7%.

Chlorophyta ranked as the 2nd group with 17.4% of total annual crop but for Shobrabas plant it represented for 15.5%. Then the 3rd group was Cyanophyta with 11.6% of total annual crop but for Shobrabas plant it accounted for 11.5%. The range, average and seasonal variation of the recorded groups can be summarized as the following:

Bacillariophyta

As shown in Tables (2, 3) the maximum count of Bacillariophyta reached (317×10^3 organisms\L) in December but for Shobrabas plant was (298×10^3 organisms\L) in February. The minimum count was (71×10^3 organisms\L) in October but for Shobrabas water plant was (187×10^3 organisms\L) in August. The most abundant species of Bacillariophyta was *Cyclotella comta* with (365×10^3 organisms\L) total number per year and high rank of occurrence but for Shobrabas plant was *Cyclotella Kutzingiana* with (501×10^3organisms\L). The rare occurrence of Bacillariophyta species was *Navicula cryptocephala*, *Cymblla lanceolata*, *Navicula radiosa* and *Stephanodiscus asteraea* with (1×10^3 organisms\L) total number per year and for Shobrabas plant was *Cymblla helvetica* with(1×10^3 organisms\L).

Chlorophyta

As shown in Tables (2,3) the minimum occurrence was (17×10^3 organisms\L) in June but for Shobrabas water plant was (18×10^3 organisms\L) in August, June and February. The maximum count of Chlorophytes (71×10^3 organisms\L) in December but for Shobrabas plant it attained (300×10^3 organisms\L) in April. The most common species was *Tetraedron minimum* with (53×10^3 organisms/L) total number per year with high rank of occurrence but for Shobrabas water plant was *Scenedesmus bijugatus* with (90×10^3 organisms/L). The rare occurrence of Chlorophyta was *Ankistrodesmus Acicularis, Cosmarium praemorsum* and *Eudorina elegans* with (1×10^3 organisms/L) total number per year but for Shobrabas plant was *Pediastrum clathratum, Pediastrum gracillium, Scenedesmus quadricauda* and *Spirogyra mirabilis* with (1×10^3 organisms/L).

Cyanophyta

As shown in Tables (2, 3) the minimum occurrence was (6×10^3 organisms\L) in August but for Shobrabas plant was (14×10^3 organisms\L) in August. The maximum count of Cyanophyta was (90×10^3 organisms\L) in December but for Shobrabas plant was (140×10^3 organisms\L) in April. The most common species of Cyanophyta was *Chrococcus turgidus* with (46×10^3 organisms\L) total number per year with a high rank of occurrence and for Shobrabas plant was *Merismopedia elegans* with (65×10^3 organisms\L). The rare occurrence was *Microcyst aeruginosa, Oscillatoria Formosa* and *Coelospharium Kutzingii* with (1×10^3 organisms\L) total number per year but for Shobrabas plant it was *Merismopdia gluca*, *Microcyst aeroginosa* with (1×10^3 organisms\L).

Table 2: A list of the recorded phytoplankton, their counts, relative density, number of cases of isolation and rank of occurrence in Shebin El-kom raw surface water plant, during the period of study

Month / Algal Groups	February	April	June	August	October	December	Total No. per year	Relative density of total (%)	No. of cases of isolation	Rank of occurrence
Bacillariophyta										
Cymblla lanceolata	0	0	0	0	2	0	2	0.15	1	R
Asterionella formosa	2	2	0	0	0	0	4	0.3	2	L
Melosira varians	5	0	0	15	7	3	30	2.2	4	M
Melosira granulata	4	10	10	7	4	6	41	3.03	6	H
Nitzschia angustata	7	6	3	0	0	24	40	3	4	M
Nitzschia linearis	0	0	0	5	5	0	10	0.74	2	L
Nitzschia amphibia	5	0	0	0	0	8	13	1	2	L
Nitzschia Palea	0	0	0	2	8	0	10	0.74	2	L
Navicula cryptocephala	0	0	2	0	0	0	2	0.15	1	R
Navicula radiosa	0	0	0	4	0	0	4	0.3	1	R
Navicula pupula	3	0	0	0	1	2	6	0.44	2	L
Fragillaria capucina	18	14	15	0	0	13	60	4.4	4	M
Fragillaria crotonensis	0	13	20	0	0	0	33	2.4	2	L
Synedra unla	20	5	3	0	0	5	33	2.4	4	M
Synedra acus	0	5	0	0	0	3	8	0.6	2	L
Diatoma vulgare	15	0	11	0	0	2	28	2.1	3	M
Diatoma elongatum	0	8	0	0	0	1	9	0.7	2	L
Stephanodiscus hantzschii	0	1	5	7	2	4	19	1.4	5	H
Stephanodiscus asteraea	0	0	0	0	0	2	2	0.15	1	R
Cyclotella kutzingiana	85	67	32	31	25	120	360	26.6	6	H
Cyclotella comta	98	81	28	17	17	124	365	27	6	H
Chlorophyta										
Actinastrum Hantzschii	3	0	0	2	1	4	10	0.74	4	M
chodatella citriformic	0	0	0	0	1	0	1	0.1	1	R
Tribodesmium lacustre	0	0	0	0	1	0	1	0.1	1	R
Hofmania Lauterbornii	0	0	1	0	0	0	1	0.1	1	R
Pseudophaerocystis lacutris	0	1	0	0	0	0	1	0.1	1	R
Closterium kutzingii	5	0	4	3	6	0	18	1.3	4	M
Pseudophaerocystis lacutris	0	1	0	0	0	0	1	0.1	1	R
Closterium kutzingii	5	0	4	3	6	0	18	1.3	4	M
Eudorina elegans	0	1	0	0	0	0	1	0.073	1	R
Nephrocytium Agradhianum	0	3	2	0	0	1	6	0.44	3	M
Kirchneriella Obesa	2	0	0	1	1	0	4	0.3	3	M
Kirchneriella lunaris	8	0	0	0	0	4	12	0.89	2	L
Tetraedron minimum	9	3	1	8	8	24	53	3.9	6	H
Cosmarium praemorsum	0	0	1	0	0	0	1	0.1	1	R
Mougeotia calospora	0	5	0	0	0	4	9	0.67	2	L
Spirogyra Mirabilis	1	1	0	0	0	0	2	0.15	2	L
Chlorella vulgaris	10	5	0	1	1	2	19	1.4	5	H
Botryococcus braunii	1	3	0	6	2	1	13	1	5	H

Ankistrodesmus Acicularis	0	0	0	0	0	2	2	0.15	1	R
Ankistrodesmus falcatus	0	2	0	0	0	4	6	0.44	2	L
Treubaria triappendiculata	3	6	0	0	0	5	14	1.03	3	M
Coelastrum microporum	0	1	1	0	0	1	3	0.22	3	M
Staurastrum paradoxum	0	0	2	0	0	5	7	0.52	2	L
Scenedesmus acuminatus	0	0	0	2	5	3	10	0.74	3	M
Scenedesmus acutus	3	0	0	0	0	1	4	0.3	2	L
Scenedesmus aramatus	8	0	1	6	0	9	24	1.8	4	M
Pediastrum duplex	0	0	2	0	0	0	2	0.15	1	R
Pediastrum gracillimum	0	0	2	0	0	0	2	0.15	1	R
Pediastrum simplex	5	4	0	1	1	1	12	0.9	5	H
Cyanophyta (b.g)										
Gomphospheria Lacustris	1	0	0	0	0	3	4	0.3	2	L
Coelospharium kuetzingianum	0	0	0	0	0	5	5	0.4	1	R
Anabaena Circinalis	0	0	3	0	0	2	5	0.4	2	L
Nostoc Linckia	4	1	0	0	0	0	5	0.4	2	L
Oscillatoria formosa	0	0	0	0	4	0	4	0.3	1	R
Oscillatoria agardhii	0	0	0	0	0	11	11	0.81	1	R
Microcyst Wesnbergii	0	2	0	0	0	0	2	0.15	1	R
Microcyst aeruginosa	0	0	0	0	0	2	2	0.15	1	R
Chrococcus limneticus	1	5	0	0	0	7	13	1	3	M
Chrococcus turgidus	3	7	24	1	5	6	46	3.4	6	H
Merismopedia glauca	1	0	0	5	5	0	11	0.81	3	M
Merismopedia elegans	5	14	2	0	0	14	35	2.6	4	M
Total No. of individuals	335	276	175	124	112	438	1460			

N.B: Filamentous and colonial organisms were counted as one organism

Total counts × 10^3= organisms / liter **H**= high occurrence :(from 5 to 6 cases of isolation)

M= moderate occurrence :(from 3 to 4 cases of isolation)

L= low occurrence: - (2 cases of isolation) **R** = rare occurrence: - (one case of isolation)

Table 3: A list of the recorded phytoplankton, their counts, relative density, number of cases of isolation and rank of occurrence in Shobrabas raw surface water plant, during the period of study (2019)

Month / Algal Groups	Feb	April	June	August	October	December	Total no. per year	Relative density of total (%)	No. of cases of isolation	Rank of occurrence
Bacillariophyta										
Cymblla helvetica	0	0	0	0	1	0	1	0.045	1	R
Melosira varians	0	90	0	0	0	6	96	4.40	2	L
Melosira granulata	1	30	10	70	3	0	114	5.22	5	H
Nitzschia angustata	19	6	7	3	7	0	42	1.92	5	H
Nitzschia amphibia	0	23	0	0	0	5	28	1.28	2	L
Nitzschia aclcularis	10	0	0	0	0	0	10	0.45	1	R
Navicula radiosa	3	0	0	0	0	0	3	0.13	1	R
Fragillaria crotonensis	0	0	26	51	0	0	77	3.53	2	L
Fragillaria capucina	16	0	20	0	10	0	46	2.10	3	M
Synedra ulna	3	2	2	4	0	5	16	0.73	5	H
Diatoma vulgare	8	2	1	2	0	2	15	0.68	5	H
Stephanodiscus hantzschii	0	0	2	1	3	0	6	0.27	3	M
Cyclotella kutzingiana	110	70	47	29	95	150	501	22.97	6	H
Cyclotella comta	128	68	85	27	75	102	485	22.23	6	H
Chlorophyta										
Actinastrum Hantzschii	1	30	1	1	0	0	33	1.51	4	M
Chodatella quardriseta	0	0	0	1	0	0	1	0.045	1	R
Oocystis lacustris	0	0	0	1	0	0	1	0.045	1	R
Excenotro sphaera virdis	0	0	0	1	0	0	1	0.045	1	R
Golenkinia radiata	0	30	0	0	1	0	21	0.96	2	L
Closterium kutzingii	0	30	0	0	0	2	32	1.46	2	L
Eudorina elegans	0	0	0	1	1	0	2	0.091	2	L
Nephrocytium Agradhianum	0	0	2	0	0	2	4	0.18	2	L
Kirchneriella Obesa	1	0	0	1	2	0	4	0.18	3	M
Kirchneriella lunaris	0	0	6	0	0	0	6	0.27	1	R
Tetraedron minimum	18	30	3	0	0	12	63	2.88	4	M
Ulothrix zonata	0	0	0	0	0	2	2	0.091	1	R
Spirogyra Mirabilis	0	0	0	0	1	0	1	0.045	1	R

Chlorella vulgaris	1	0	0	3	0	0	4	0.18	2	L
Botryococcus braunii	0	0	1	0	0	5	6	0.27	2	L
Ankistrodesmus falcatus	0	0	2	0	2	0	4	0.18	2	L
Treubaria triappendiculata	1	0	1	1	0	0	3	0.13	3	M
Coelastrum microporum	1	30	2	0	0	4	37	1.69	4	M
Staurastrum polymorphum	0	0	0	0	7	0	7	0.32	1	R
Staurastrum gracile	3	0	1	0	0	0	4	0.18	2	L
Staurastrum paradoxum	0	0	0	1	0	0	1	0.045	1	R
Scenedesmus acuminatus	0	0	3	3	0	0	6	0.27	2	L
Scenedesmus bijugatus	0	90	0	0	0	0	90	4.12	1	R
Scenedesmus quadricauda	0	0	1	0	0	0	1	0.045	1	R
Scenedesmus armatus	3	60	1	0	15	10	89	4.08	5	H
Pediastrum duplex	0	0	1	2	0	3	6	0.27	3	M
Pediastrum gracillimum	0	0	1	0	0	0	1	0.045	1	R
Pediastrum boryanum	0	0	1	1	0	0	2	0.091	2	L
Pediastrum clathratum	0	0	0	1	0	0	1	0.045	1	R
Pediastrum simplex	1	0	2	0	4	0	7	0.32	3	M
Cyanophyta										
Gomphospheria Lacustris	0	0	0	0	5	0	5	0.22	1	R
Anabaena sphaerica	0	0	1	1	0	8	10	0.45	3	M
Coelosphaerium kuetzingianum	0	30	0	0	15	0	30	1.37	2	L
Oscillatoria formosa	0	3	1	0	0	0	31	1.42	2	L
Oscillatoria agardhii	0	30	0	0	2	0	32	1.46	2	L
Spirulina Platensis	2	0	0	0	0	0	2	0.091	1	R
Microcyst aeruginosa	0	0	0	0	0	1	1	0.045	1	R
Chrococcus limneticus	10	0	29	0	0	3	42	1.92	3	M
Chrococcus turgidus	38	0	0	11	5	0	54	2.47	3	M
Merismopedia glauca	0	0	0	0	0	1	1	0.045	1	R
Merismopedia elegans	5	50	0	2	6	2	65	2.98	5	H
Total No. of individuals	382	731	260	223	260	325	2181			

N.B: Filamentous and colonial organisms were counted as one organism
Total counts × 10^3= organisms / liter **H**= high occurrence : (from 5 to 6 cases of isolation)
M= moderate occurrence : (from 3 to 4 cases of isolation)
L= low occurrence: - (2 cases of isolation) **R** = rare occurrence: - (one case of isolation)

Table 4: Percentage distribution of the phytoplankton groups of raw water at Shebin El-kom surface water plant and Shobrabas surface water plant, during the period of study (2019)

Algal groups		Feb		Apr		Jun		Aug		Oct		Dec		S		C		P-value
		S	C	S	C	S	C	S	C	S	C	S	C	Mean	SD	Mean	SD	
Bacillariophyta	Species No.	11	9	11	8	10	9	8	8	9	7	21	6	11.7	4.7	7.8	1.2	0.08
	% of total	37.9	40.9	39.2	42.1	43.4	31	42.1	33.3	40.9	35	55.2	31.6	43.2	6.2	35.7	4.8	0.04*
	Individual No.	262	298	212	291	129	200	88	187	71	194	317	270	179.8	99.5	240.0	51.7	0.22
	% of total	78.2	78	76.8	39.8	73.7	76.9	70.9	83.9	63.4	74.6	72.4	83.1	72.6	5.3	72.7	16.5	0.98
Chlorophyta	Species No.	12	9	12	7	10	17	9	13	10	8	16	8	11.5	2.5	10.3	3.9	0.55
	% of total	41.3	40.9	42.8	36.8	43.4	58.6	47.4	54.2	45.5	40	42.1	42.1	43.8	2.2	45.4	8.8	0.66
	Individual No.	58	30	35	300	17	29	30	18	27	33	71	40	39.7	20.5	75.0	110.5	0.46
	% of total	17.3	7.8	12.6	41	9.7	11.2	24.2	8.1	24.1	12.7	16.2	12.3	17.4	5.9	15.5	12.7	0.75
Cyanophyta	Species No.	6	4	5	4	3	3	2	3	3	5	8	5	4.5	2.3	4.0	0.9	0.63
	% of total	20.6	18.1	17.8	21	13	10.3	10.5	12.5	13.6	25	21.1	26.3	16.1	4.4	18.9	6.5	0.41
	Individual No.	15	55	29	140	29	31	6	14	14	33	90	15	30.5	30.5	48.0	47.5	0.47
	% of total	4.4	14.3	10.5	19.2	16.6	11.9	4.8	6.3	12.5	12.7	20.6	4.6	11.6	6.4	11.5	5.3	0.98

S: Shebin El- kom surface water plant C: Shobrabas surface water plant, Total counts × 10^3= organisms / liter

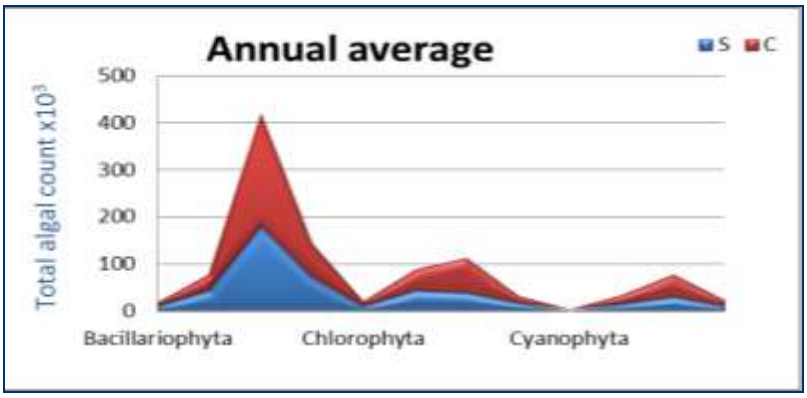


Fig. (2): The annual average of algal groups of Nile water at Shebin El-kom surface water plant and Shobrabas surface water plant, during the period of study (2019)

Treated water of Shebin El-kom water plant and Shobrabas water plant

As shown in Table (5) and represented by Fig. (3) the total number of phytoplankton populations per year in Shebin El-kom treated water was (69×10³ organisms\L) while for Shobrabas water plant was (885×10³ organisms\L). The efficiency of treatment according to the total number of phytoplankton populations per year in raw and treated water for Shebin Elkom plant was (95.3%) while for Shobrabas plant was (59.4%). The highest count was (34×10³ organisms\L) in February followed by April with yield of (11×10³ organisms/L) in Shebin El-kom water plant while in Shobrabas water plant the highest count was (263× 10³ organisms\L) in April followed by December with yield of (223×10³ organisms/L). On the other hand, the minimum yield was (5×10^3 organisms\L) in August and december followed by October with yield of (6×10³ organisms\L) in Shebin El-kom water plant while in Shobrabas water plant the minimum yield was (85×10^3 organisms\L) in June followed by February with yield of (99×10³ organisms\L) .April and June showed moderate values (11, 9×10³ organisms\L) respectively in Shebin El-kom water plant while in Shobrabas water plant August and October showed moderate values (106,109×10³ organisms\L), respectively.

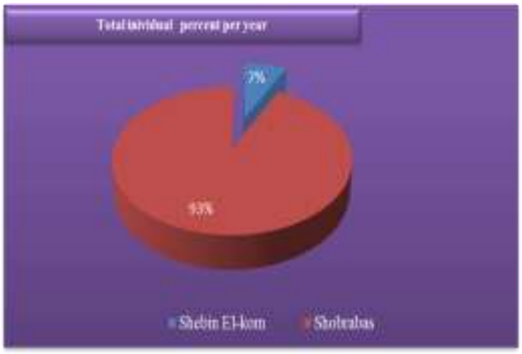


Fig. (3): Total individual percent per year at Shebin El-Kom and Shobrabas treated surface water, during the period of investigation

Table 5: Distribution of algal groups in treated water in Shebin El-kom and Shobrabas surface water plants, during the period of investigation

Month / Algal Groups	February		April		June		August		October		December		Total No. per year		Relative density of total (%)		No. of cases of isolation		Rank of occurrence	
	S	C	S	C	S	C	S	C	S	C	S	C	S	C	S	C	S	C	S	C
Bacillariophyta																				
Melosira varians	3	0	0	0	2	0	0	2	0	0	1	2	6	4	8.69	0.45	3	2	M	L
Melosira granulata	1	0	0	0	0	3	0	13	1	2	0	0	2	18	2.89	2.03	2	3	L	M
Nitzschia amphibia	2	1	0	0	1	0	0	0	0	0	1	0	4	1	5.79	0.11	3	1	M	R
Nitzschia aclcularis	1	0	0	32	0	5	0	0	0	0	0	0	1	37	1.45	4.18	1	2	R	L
Nitzschia angustata	0	10	0	0	0	0	0	8	0	3	0	4	0	25	0	2.82	0	4	_	M
Neidium iridis	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0.11	0	1	_	R
Navicula cryptocephala	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0.22	0	1	_	R
Navicula pupula	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1.45	0	1	0	R	_
Asterionella formosa	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0.11	0	1	_	R
Fragillaria capucina	0	0	0	0	0	0	0	5	0	0	0	0	0	5	0	0.56	0	1	_	R
Fragillaria crotonensis	0	0	0	0	0	0	0	0	0	0	0	3	0	3	0	0.33	0	1	_	R
Syndra ulna	0	1	0	0	0	0	0	1	0	0	0	2	0	4	0	0.45	0	3	_	M
Diatoma elongatum	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0.22	0	1	_	R
Diatoma vulgare	0	0	0	0	0	0	0	0	0	0	0	4	0	4	0	0.45	0	1	_	R
Cyclotella kutzingiana	3	31	2	135	0	39	0	35	1	46	0	102	6	388	8.69	43.84	4	6	M	H
Cyclotella comta	3	15	2	46	2	13	1	19	1	28	1	68	10	189	14.49	21.35	6	6	H	H
Stephanodiscus hantzschii	0	0	0	0	0	0	0	2	0	1	0	3	0	6	0	0.67	0	3	_	M
Chlorophyta																				
Actinastrum Hantzschii	1	0	0	0	0	0	1	0	0	0	0	0	2	0	2.89	0	2	0	L	_
Excentrosphaera virdis	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0.112	0	1	_	R
Closterium kutzingii	1	0	0	1	0	0	0	0	0	0	1	0	2	1	2.89	0.112	2	1	L	R
Nephrocytium Agradhianum	0	0	1	0	0	0	0	0	0	0	0	0	1	0	1.45	0	1	0	R	_
Nephrocytium subsolitaria	0	0	0	1	0	0	0	3	0	0	0	0	0	4	0	0.451	0	2	_	L
Kirchneriella lunaris	0	0	0	0	0	1	0	0	0	0	0	6	0	7	0	0.79	0	2	_	L
Kirchneriella obesa	0	1	0	0	0	5	0	2	0	1	0	0	0	9	0	1.016	0	4	_	M
Chlorella vulgaris	2	5	0	3	1	4	0	0	0	2	0	0	3	14	4.35	1.58	2	4	L	M
Tetraedron minimum	4	20	1	10	1	1	0	1	1	5	1	7	8	44	11.59	4.97	5	6	H	H
Mougeotia calospora	0	0	0	0	0	0	0	0	0	2	0	0	0	2	0	0.225	0	1	_	R5
Botryococcus braunii	0	0	0	4	0	2	0	0	0	4	0	3	0	13	0	1.46	0	4	_	M
Treubaria triappendiculata	2	1	0	0	0	0	0	0	0	0	0	0	2	1	2.89	0.112	1	1	R	R
Chodattella subsaisa	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0.225	0	1	_	R
Coelastrum microporum	0	0	0	0	0	0	1	0	1	0	0	1	2	1	2.89	0.112	2	1	L	R
Staurastrum gracile	1	0	0	0	0	0	0	0	0	1	0	0	1	1	1.45	0.112	1	1	R	R
Scenedesmus acutus	1	0	0	0	0	0	0	0	0	1	0	0	1	1	1.45	0.11	1	1	R	R
Scenedesmus bijugatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	_	_
Scenedesmus armatus	1	5	0	0	0	0	2	0	0	4	0	3	3	12	4.34	1.35	2	3	L	M
Pediastrum duplex	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0	0.225	0	1	_	R
Pediastrum gracillimum	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0.225	0	1	_	R
Pediastrum clathratum	0	0	0	2	0	0	0	0	0	0	0	0	0	2	0	0.22	0	1	_	R
Pediastrum simplex	1	1	1	0	0	1	0	0	0	2	0	0	2	4	2.89	0.45	2	3	L	M
Cyanophyta																				
Oscillatoria tenuis	0	0	0	5	0	0	0	0	0	0	0	0	0	5	0	0.56	0	1	_	R
Coelospharium kuetzingianum	0	0	1	0	0	0	0	0	0	0	0	0	1	0	1.45	0	1	0	R	_
Anabaena sphaerica	0	0	0	0	0	0	0	1	0	0	0	2	0	3	0	0.33	0	2	_	L
Gomphosphaeria lacustris	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0.112	0	1	_	R
Chrococcus limneticus	1	1	0	0	1	0	0	0	1	0	0	4	3	5	0.04	0.56	3	2	M	L
Spirulina platensis	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0.11	0	1	_	R
Merismopedia glauca	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1.45	0	1	0	R	_
Merismopedia elegans	3	2	2	22	0	3	0	2	0	3	0	3	5	35	7.25	3.95	2	6	L	H
Chrococcus turgidus	2	3	1	2	0	8	0	5	0	3	0	0	2	21	2.89	2.37	2	5	L	H
Total No. of individuals	34	99	11	263	9	85	5	106	6	109	5	223	69	885						

N.B: Filamentous and colonial organisms were counted as one organism **Total counts × 10^3=** organisms / liter **H=** high occurrence :(from 5 to 6 cases of isolation) **M=** moderate occurrence :(from 3 to 4 cases of isolation) **L=** low occurrence: - (2 cases of isolation) **R=** rare occurrence: - (one case of isolation)

Modification of Shobrabas compact water plant

Physicochemical parameters before and after modification

As shown in Table (6) the physicochemical parameters weren't affected negatively, some parameters were decreased such as turbidity, total dissolved solids (TDS) and conductivity. The remaining parameters had slightly changes after modification. The remaining parameters had slightly changes with using both. Turbidity of raw water was 11 NTU, the average of turbidity for 3 samples collected respectively decreases after modification from (2.3 to 1.4) NTU. TDS of raw water was 240 mg/L, the average of TDS for 3 samples collected respectively decreases after modification from (234.3 to 220) mg/L. Conductivity of raw water was 363 µS/cm, the average of Conductivity for 3 samples collected respectively decreases after modification from (354.7 to 332.7) µS/cm . Phosphate of raw water was 0.39 mg\L, the average of phosphate for 3 samples collected respectively slightly increases after modification from (0.3 to 0.4) mg\L. Total alkalinity of raw water was 167 mg\L, the average of phosphate for 3 samples collected respectively slightly decreases after modification from (156.3 to 154) mg\L. Chlorides of raw water was 25 mg\L, the average of chlorides for 3 samples collected respectively increases after modification from (32.3 to 36) mg\L.

Table 6: Comparison between physicochemical parameters in treated water before and after modification of shobrabas plant during the period of study (2019)

Parameters	Raw water	Shobrabas before modification					Shobrabas after modification					P- value
		S1	S2	S3	Mean	S.D	S1	S2	S3	Mean	S.D	
Turbidity (NTU)	11	1.8	2.1	2.9	2.3	0.6	1	1.3	1.8	1.4	0.4	P 1=0.001* P 2=0.001* P 3=0.012*
pH	7.9	7.5	7.7	7.9	7.7	0.2	7.6	7.7	7.8	7.7	0.1	P 1=0.22 P 2=0.07 P 3=0.99
TDS (mg/L)	240	238	235	230	234.3	4.0	225	220	215	220	5	P 1=0.13 P 2=0.02* P 3=0.002*
Conductivity (µS/cm)	363	360	356	348	354.7	6.1	340	333	325	332.7	7.5	P 1=0.14 P 2=0.02* P 3=0.002*
Iron (mg/L)	0.02	0.18	0.2	0.1	0.2	0.1	0.2	0.18	0.22	0.2	0	P 1=0.04* P 2=0.015* P 3=0.677
Manganese (mg/L)	0.12	0.01	0.1	0.1	0.1	0.0	0	0.01	0.02	0	0	P 1=0.17 P 2=0.001* P 3=0.199
Total hardness (mg/L)	167	155	160	158	157.7	2.5	154	165	150	156.3	7.8	P 1=0.02* P 2=0.014* P 3=0.757
Calcium. H (mg/L)	85	80	84	90	84.7	5.0	75	81	86	80.7	5.5	P 1=0.91 P 2=0.30 P 3=0.02*
Magnesium hardness (mg/L)	82	71	78	88	79	8.5	73	75	90	79.3	9.3	P 1=0.61 P 2=0.67 P 3=0.86
Ca^{2+}(mg/L)	34	32	33	36	33.7	2.1	30	32	34	32	2	P 1=0.81 P 2=0.23 P 3=0.03*
Mg^{2+} (mg/L)	19	17	18	21	18.7	2.1	17	18	21	18.7	2.1	P 1=0.81 P 2=0.81 P 3=1.0
Total alkalinity (mg/L)	167	150	157	162	156.3	6.0	154	160	148	154	6	P 1=0.92 P 2=0.06 P 3=0.73
Chlorides (mg/L)	25	33	34	30	32.3	2.1	36	40	32	36	4	P 1=0.03* P 2=0.04* P 3=0.09
Sulfate (mg/L)	28	30	39	40	36.3	5.5	36	38	41	38.3	2.5	P 1=0.12 P 2=0.019* P 3=0.44
Phosphate (mg/L)	0.39	0.25	0.35	0.4	0.3	0.1	0.3	0.4	0.47	0.4	0.1	P 1=0.37 P 2=0.92 P 3=0.03*
Nitrate (mg/L)	0.5	0.32	0.29	0.3	0.3	0.0	0.2	0.25	0.33	0.3	0.1	P 1=0.002* P 2=0.019* P 3=0.43
Ammonia (mg/L)	0.36	0.2	0.32	0.3	0.3	0.1	0.3	0.34	0.31	0.3	0	P 1=0.16 P 2=0.15 P 3=0.25

S1: sample no1 of water **S2**: sample no2 of water **S3**: sample no3 of water **P1**: raw water **vs:** treated water before modification
P2: raw water **vs**: treated water after modification **P3**: Treated water before modification **vs**: Treated water after modification

Algal removal

As shown in Table 7 the total number of phytoplankton populations in raw water was (718×10³ organisms/ L).The average of total algal count before modification was (103×10³ organisms/L) and the efficiency of treatment reached 85.6% removal, on other hand after modification the average of total algal count was (26×10³ organisms/L) and the efficiency of treatment was very high and reached 96 % removal.

Table 7: Comparison between the total algal count in treated water before and after modification of Shobrabas plant

Algal groups		Raw water	Treated water of Shobrabas before modification				Treated water of Shobrabas after modification			
			S1	S2	S3	Av	S1	S2	S3	Av
Chlorophyta	*Pediastrum simplex*	2	2	1	0	1	1	0	0	0
	Pediastrum duplex	1	0	1	0	0	0	0	0	0
	Scenedesmus armatus	58	5	3	1	3	1	0	0	0
	Scenedesmus bijugatus	4	1	2	0	1	0	1	0	0
	Scenedesmus acuminatus	75	6	2	4	4	2	0	1	1
	Staurastrum paradoxum	2	1	0	0	0	0	0	0	0
	Coelastrum microporum	35	2	3	1	2	0	1	0	0
	Treubaria triappendiculata	2	0	1	0	0	0	0	0	0
	Ankistrodesmus falcatus	1	0	0	0	0	0	0	0	0
	Botryococcus braunii	2	0	0	1	0	0	0	0	0
	Chlorella vulgaris	1	0	0	0	0	0	0	0	0
	Tetraedron minimum	15	2	1	1	1	2	1	0	1
	Kirchneriella lunaris	4	1	0	1	1	0	0	0	0
	Kirchneriella Obesa	1	0	0	0	0	0	0	0	0
	Nephrocytium Agradhianum	1	0	0	0	0	0	0	0	0
	Eudorina elegans	1	0	0	0	0	0	0	0	0
	Closterium kutzingii	30	2	3	1	2	1	4	2	2
	Golenkinia radiata	10	1	2	4	2	0	0	1	0
	Actinastrum Hantzschii	30	5	1	0	2	1	0	0	0
Bacillariophyta	*Cyclotella comta*	68	12	11	15	13	3	2	1	2
	Cyclotella kutzingiana	70	35	25	18	26	15	10	3	9
	Diatoma elongatum	2	0	1	1	1	0	0	0	0
	Diatoma vulgare	2	1	0	1	1	0	0	0	0
	Synedra ulna	2	0	1	0	0	1	0	0	0
	Nitzschia acicularis	10	4	2	5	4	1	0	1	1
	Nitzschia amphibia	23	3	1	2	2	1	0	0	0
	Nitzschia angustata	6	0	0	1	0	0	0	0	0
	Melosira granulata	30	3	2	4	3	1	0	1	1
	Melosira varians	90	4	6	2	4	1	2	0	1
Cyanophyta	*Merismopdia elegans*	50	20	12	15	16	5	3	1	3
	Merismopdia glauca	2	0	1	0	0	0	0	0	0
	Chrococcus turgidus	1	0	0	2	1	0	1	0	0
	Microcyst aeruginosa	5	0	1	2	1	0	0	0	0
	Spirolina Platensis	2	1	0	1	1	0	0	0	0
	Oscillatoria agardhii	30	3	1	4	3	1	0	1	1
	Oscillatoria formosa	20	12	3	5	7	2	0	0	1
	pelosphaerium kuetzingianu	30	1	0	3	1	0	0	1	0
Total algal count		718	127	87	95	103	39	25	13	26
Efficiency of treatment %			82.3	87.8	86.7	85.6	94.5	96.5	98.1	96

Total counts × 10^3= organisms / liter

Algal groups	Raw water	Before modification		After modification		P- value
		Mean	S. D	Mean	S. D	
Chlorophyta	275	20.7	7.02	6.3	2.1	P1=0.001* P2=0.001* P3=0.04*
Bacillariophyta	303	53.3	7.5	14.3	8.5	P1=0.00** P2=0.00** P3=0.003*
Cyanophyta	140	29.0	9.8	5.0	2.6	P1=0.00** P2=0.00** P3=0.041*
Total algal count	718	103	21.2	25.7	13.0	P1=0.00** P2=0.00** P3=0.010*
Efficiency of treatment (%)		85.6	2.9	96.4	1.8	P3=0.010*

P1: raw water **vs** treated water before modification **P2:** raw water **vs** treated water after modification **P3:** treated water before modification **vs** treated water after modification

Discussion

In this study, physicochemical parameters and algal distribution were investigated in raw and treated water water of Shebin El-Kom surface water plant and Shobrabas compact water plant. Temperature is considered as a very significant factor influencing various activities of the microorganisms **(Galal *et al.*, 2011 and Gopalkrushna, 2011).** It has a positive significant correlation with turbidity in both conventional and compact water plants **(Galal, *et al.*, 2014).** Turbidity of water is caused by suspended particles, primarily of clay, silt, organic matter, and microorganisms **(APHA, 2010)**. It is the most widely used measurements in water treatment process that include coagulation, sedimentation and filtration **(WHO, 2009).** Hydrogen ion concentration is considered as a controlling factor affecting dissolved oxygen and total alkalinity. Its values in the present study ranged between7.1-8.2. In this study higher pH values were on summer as compared to those of winter and other seasons which could be referred to the decomposition of the organic matter which is confirmed by **(Birhanu, 2007).** TDS achieved the maximum values on winter rather than in summer, as a large amount of sediment load was transported from the watershed during the rainy season in all water samples which agreed with **(Elewa and Mahdi, 1988)** Simultaneously, TDS values showed high positive correlation with the electrical conductivity which is confirmed with data obtained by **(Galal, *et al.*, 2014).** Total hardness depends on the value of TDS, as if the value of total dissolved salts (containing calcium and magnesium salts) is high, the water hardness increases. These results were agreed with **(Hisham *et al.*, 2015 and Galal *et al.*, 2017).** Iron was ranged from <0.01 ppm to 0.30 ppm and manganese was ranged from <0.01 ppm to 0.20 ppm. The presence of iron and manganese at different water treatment stages and at the drinking water distributing system could be referred to the using of ferric coagulants as well as using steel pipes which is confirmed by **(Thompson *et al.*, 2009).** Ammonia is considered as indicator of bacterial and sewage pollution. The seasonal values of ammonia in Shebin El-kom showed less concentration on spring and high levels during summer, while in Shobrabas the low levels were in winter and high levels were in autumn. The range of nitrate was from 0.07 ppm to 0.62 ppm. The highest value was in June and the lowest value was during April. Nitrates can reach both surface and ground water as a consequence of agricultural activity and also from waste water disposal product from human. Phosphates are very important elements for phytoplankton growth. It stimulates the activity of nitrogen fixing bacteria and increasing the nitrifying activity of the soil **(Authman, 1991)**. In the present study phosphate levels ranged from 0.01 ppm to 0.66 ppm that exceed those of the Environmental Protection Agency limits (0.1 mg) which could be an indication of sewage contamination. **(Singh *et al.*, 2021).** Algal count is often a necessary indicator of water quality. The results of this study had various phytoplankton structures including three groups: Bacillariophyta, Chlorophyta and Cyanophyta. Bacillariophyta represented the most abundant group and Chlorophyta and Cyanophyta were ranked as the 2nd group and 3rd group in their occurrence, resepectively. These results were agreed with **(Allam and El-Gemaizy, 2015; Onyema, 2017).** Algal distribution was affected by temperature as the highest numbers were indicated in warmer seasons, as autumn and spring in both water plants while the lowest counts were recorded in summer. This agreed with **(Hussian *et al.*, 2015 and Khairy *et al.*, 2015)** except a special case in Shebin-El-kom plant as the highest algal count was in December then February in and also in February at Shobrabas water plant and this was due to the winter closure period in Egypt **(Galal *et al.*, 2015).** In this period water level was highly decreased in the river and this affected the rate of water flow in the river as it highly decreased and this in turn resulted in high phytoplankton population as algal population is inversely proportional to water level **(APHA, 2010).** Bacillariophyta percentage was 72.7% of total annual count. The maximum accumulation was ((317×10^3 organisms\L) in December and the minimum occurrence was (71×10^3 organisms\L) in October. The increase in Bacillariophyta can be seen as an ecological advantage, supplying energy for the planktonic web and they have been used to investigate the natural and the anthropogenic influences on biodiversity **(Calliaria *et al.*, 2005; Hussian *et al.*, 2015)**. The most common Bacillariophyta species was *Cyclotella comta* with (10×10^3 organism/L) per year with high rank of occurrence in Shebin El-kom treated water while in Shobrabas treated water was *Cyclotella kutzingiana* with (388×10^3 organism/L) per year with high rank of occurrence and these results agreed with **(Dango *et al.*, 2015; Onyema, 2017).** Chlorophyta percentage was 15.5% of total annual count. The most common Chlorophyta species in Shebin El-kom was *Tetraedron minimum* with (8×10^3 organism/L) total number per year and also in Shobrabas with (44×10^3 organism/L) total number per year. The presence of high density of Cyanophyta indicates high pollution load and nutrient rich condition **(Sharma *et al.*, 2016).** Cyanophyta percentage was 11.5% of total annual count. The most common Cyanophyta species in Shebin El-kom was *Merismopedia elegans* with (5×10^3 organism/L) total number per year and also in Shobrabas with (35×10^3 organism/L) total number per year. The coagulation and flocculation are considered as main method for removing colloidal inorganic and organic suspensions which could be a good support for pathogens growth, and presents great problems to drinking water aspect **(Shaaban *et al.*, 2019; Mohamed *et al.*, 2020).** Conventional water treatment plant (Shebin El-kom) has a series of treatment processes such as coagulation, flocculation and clarification through sedimentation, filtration and disinfection. While direct filtration compact water treatment plant (Shobrabas) is considered as a conventional plant without clarifiers. Considering the previous physicochemical and biological results it was proved that Shebin El-kom water plant was more compelling than Shobrabas compact water plant in producing potable water. When it was laborious to pull an end to the compact water plants, modification of the plant was accomplished leading to a reduced turbidity, total dissolved solids (TDS) and conductivity. Turbidity decreased in treated water after modification (from 2.3 to 1.4) NTU. TDS decreased from (from 234.3 to 220) mg/L. The total number of phytoplankton populations in raw water was (718×10^3 organisms/L) and the average of total algal count before modification was (103×10^3 organisms/L) and the capability of treatment reached 85.6%, but after modification, nutrient supply decreased due to the decrease of turbidity therefor the average of total algal count of treated water was (26×10^3 organisms/L) and the capability of treatment enhanced to 96 %. This agreed with **(Hussian *et al.*, 2015).**

Conclusion

The conventional treatment plant (Shebin El-kom) was more compelling than compact water treatment plant (Shobrabas) considering the physicochemical and biological parameters. In Egypt it was laborious to pull an end to the compact water plants so a modification stage was accomplished to drain turbidity and algal count. The efficiency of treatment commutated from 85.6% to 96%.

Author contributions: MTS and HHM conceived and designed the structure of the article. MTS, SAG, and HHM performed the literature search and the data analysis. MTS, SAG, and HHM wrote the first draft of the manuscript. MTS and HHM reviewed the manuscript. SAG carried out the experiments .All authors read and approved the final version of the manuscript.

Acknowledgements: The authors are thankful to Botany and Microbiology Department, Faculty of Science, Menoufia University, Egypt, for providing scientific support to carry out this research.

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الصورة الكيميائية ووالهائمات النباتية لنموذجين من محطات مياه الشرب قبل وبعد المعالجة بمحافظة المنوفية - مصر

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الماء ضروري لاستمرار الحياة، وتوافر المياه الصالحة للشرب أمر بالغ الأهمية تناولت هذه الدراسة مقارنة بين محطات مختلفة لمعالجة مياه الشرب بشبين الكوم (محطة شبين الكوم لمعالجة المياة بالطريقة التقليدية، محطة شبراباص المرشحة وهي عبارة عن محطة نقالي) تمت الدراسة في الفترة من فبراير – ديسمبر ٢٠١٩.

وتتضمن هذه الدراسة:-

التحاليل الفيزيائية والكيميائية والبيولوجية لرصد محطات مختلفة في مدينة شبين الكوم وعمل تقييم لتقدير كفاءتها لمعالجة مياه الشرب مثل العكارة والقلوية والتوصيل الكهربي والاملاح الذائبة والفوسفات والنترات. ويمكن تلخيص نتائج هذه الدراسة كالآتي:-

وجد انه بالنسبة لنتيجة العكارة الخاصة بالمياه المعالجة لمحطة شبراباص النقالي مرتفعة حيث تراوحت من ١.٦ NTU : ٣ NTU بالمقارنة مع عكارة المياه المعالجة لمحطة شبين الكوم التى تراوحت من ٠.٣٣ NTU : ٠.١٨ NTU. يعتبر العد الطحلبي للمياه السطحية جزءاً ضرورياً لرصد كفاءة المياه وفي الأبحاث الخاصة بدراسة الطحالب. وأظهرت نتائج هذه الدراسة أن الطحالب التي تم دراستها تنتمي إلي ثلاث مجموعات رئيسية وهي الدياتومات، الطحالب الخضراء، الطحالب الخضراء المزرقة وكانت هذه المجموعات متنوعة في أعداد الطحالب خلال فترة الدراسة.وقد كان العدد الكلي للطحالب خلال فترة الدراسة في المياه العكرة لمحطة شبرا باص أعلي من العدد الكلي للمياه المعالجة لمحطة شبين الكوم وكانت مجموعة الطحالب البنية هي الأكثر شيوعاً في كل من شبين الكوم وشبرا باص بنسبة 72.6%و 72.7 % بالتوالي يليها مجموعة الطحالب الخضراء بنسبة 17.4% و 15.5%علي التوالي.ثم مجموعة الطحالب الخضراء المزرقة بنسبة 11.6 %و 11.5 % بالتتابع لذلك كانت محطة شبين الكوم التقليدية أكثر كفاءة من شبراباص في إنتاج مياه الشرب. وأثبتت هذه الدراسة المشاكل المختلفة بتصميم محطة شبرا باص النقالي وقد تم القيام بعمل بعض التعديلات وذلك لتحسين إزالة الأنواع المختلفة من الطحالب وأيضاً تقليل العكارة حيث انخفضت بعض المؤشرات الفيزيائية والكيميائية مثل العكارة، الأملاح الذائبة الكلية والتوصيل الكهربي بينما لم تتأثر بعض العوامل الأخري بالسلب. وقد قلت العكارة بنسبة جيدة في عينات المياه المعالجة بعد تعديل المحطة حيث انخفض متوسط العكارة من (2.3NTU إلي 1.4 NTU).وقد كان التعديل أكثر فاعلية في إزالة الطحالب حيث انخفض العدد الطحلبي من (١٠^{3} × ١٠٠٠ إلي ١٠^{3} × ٢٦) ونتيجة لذلك ازدات كفاءة المعالجة حيث وصلت إلي ٩٦% بعد أن كانت ٨٥.٦%

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