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Comparative Studies on Cladophora Glomerata and Chaetomorpha Vieillardi (Cladophoraceae) at North Delta-Egypt

Seham E. Abu Ahmed[*1], Mohamed A. Deyab[1], Radwa S. El-Shanawany[1] and Magda F. El-Adl[1]

[1] Department of Botany and Microbiology, Faculty of Science, Damietta University, New Damietta 34517, Egypt

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[*] Corresponding author's E-mail: Dr_Seham2016@yahoo.com

Abstract

This study aims to compare between the marine alga *Chaetomorpha vieillardi* and the freshwater alga *Cladophora glomerata*. Water samples and massive growth of two species were collected from Port Said marine water pond and Ras El-Bar freshwater pond, respectively in 2019. The highly massive growth of *Ch. vieillardi* and *C. glomerata*, due to the trophic status and optimal physico-chemical properties of their habitats, causes ecological and economic problems. The very high massive growth of two species leads to relatively complete elimination of dissolved oxygen (DO) at the middle and bottom level of water during the second half of the night. Loss of DO values led to great loss of aquaculture. Although both algal species were belonging to the same family, yet they prefer different habitats where, *Ch. vieillardi* formed bloom in marine water but *C. glomerata* in freshwater. The significant variation in the biochemical, phytochemical compositions and heavy metal bioaccumulation capacity of *Ch. vieillardi* and *C. glomerata* could be attributed to the variation in biological properties of two species and the physicochemical characteristics of their habitats. *Ch. vieillardi* has higher carbohydrate and lipid content compared to *C. glomerata*. Most heavy metals accumulated in *C. glomerata* was more than that in *Ch. vieillardi*, but Cu and Fe were highly accumulated in *Ch. vieillardi*.

Keywords: Biochemical composition; Chaetomorpha vieillardi; Cladophora glomerata; physicochemical analysis.

Introduction

In the north of Egypt, particularly Damietta Province, the environmental conditions of the aquatic ecosystems, are quite suitable for the development of massive algal blooming, thus leading to water pollution and imposing serious threats to the aquatic organisms, quality of water and economic problems. Increasing water turbidity and cyanobacterial blooming have reported to be the causative agents of gastrointestinal illness **(Beaudeau *et al.* 2008)**. In addition, the continuous discharge of agricultural and domestic effluents into the shallow waters might aggravate the problem through over-enrichment with nutrients, in particular nitrogen and phosphorus **(Selvi Dhanam *et al.* 2013)**.
Filamentous and benthic chlorophyte Harmful Algal Blooms (HABs) can affect directly or indirectly on other biota. Excessive occurrence of algal thalli interferes with the growth of abalone and sea cucumber directly. Decomposing algal mats consume dissolved

oxygen and result in a hostile physic–chemical environment for marine animals **(Chi *et al.* 2009; Deng *et al.* 2011a, b)**. Periodical abundances of this macroalga have a great effect on water quality and sometimes cause great loss of aquaculture **(Chi *et al.* 2009; Deng *et al.* 2011a, b)**.

Algae need suitable environmental conditions as temperature, luminous intensity, ultraviolet light, salinity, dissolved gases, nutrients to produce massive growth or blooms (**Gressler 2010**). These factors promote algae to produce secondary metabolites by processing and converting the primary metabolites of algae **(Gressler 2010)**. These secondary metabolites don't have a direct effect on algal survival, but they play important roles in maintaining natural defense mechanisms by inducing anti-oxidant, anti-viral and anti-microbial activities **(Pulz and Gross 2004)** to protect algae from changes in the surroundings **(Laungsuwon and Chulalaksananukul 2013)**.

Cladophora glomerata is a filamentous green macroalga with a typically branched thalli **(Bellis *et al*. 1967)** . Algae from the genus *Cladophora* occur both in marine and in freshwater habitat. *Cladophora glomerata* is a cosmopolitan species mass occurring in Polish inland waters in the form of free-floating mats on the water **(Schroeder *et al*. 2013).**

Algae of genus *Chaetomorpha* are made up of macroscopic filaments of cylindrical cells. The genus is characterized by its unbranched filaments, making it distinctive; its closest relatives are branching species of the genus *Cladophora* **(Choudhury *et al*. 2005).**

Massive growth of *Chaetomorpha* and *Cladophora* spp. causes adverse problems, especially when loose algal mats accumulate and decompose. This problem has not been attracting much attention to appropriately benefit from them for human health or avoiding the negative effects on aquatic systems.

So, this study aimed to investigate the massive growth of *Chaetomorpha vieillardi* and freshwater alga *Cladophora glomerata* through studying the physicochemical characteristics of their water and their phytochemical, biochemical composition and their heavy metal bioaccumulation capacity.

Materials and Methods

Sampling collection

Figure 1: Location map of Mediterranean Sea showing sampling sites

Surface water and algal bloom samples, *Cladophora* sp and *Chaetomorpha* sp, were collected manually from a fresh water pond at Ras El-Bar (S1) and marine water pond at Port Said (S2), respectively Fig. 1. Abundance was estimated by placing a quadrate measuring 1 m^2 at the sampling points in triplicate. Algal samples within the quadrat were collected and estimated then rinsed well with water to eliminate any adhering substances. These samples were transported to the laboratory in plastic bags under iced conditions as soon as possible.

Preparation of algal samples

The samples were washed thoroughly with tap water, then with distilled water to get rid of salts and other pollutants. The algal thalli were divided into two parts; a part was stored in -80°C for molecular identification and another part was dried in air at room temperature, and then dried in an oven at 80°C for 24 h, afterwards it stored until analysis. The algal species were identified ecologically and morphologically according to **Aleem (1993) and Coppejans *et al.* (2009**).

Water Physico-chemical properties

Temperature and pH of water were determined *in situ* by using a thermometer and a Horizon (Co 5995) pH meter, respectively. EC and TDS were measured directly using YK-22 CT Conductivity/TDS meter. Phenolphthalein alkalinity (Ph. Ph. Alk) and total alkalinity (T Alk.), dissolved oxygen (DO) every 2h for 24h along water column (surface, middle and bottom), BOD, CO_2, COD, cations (Ca^{2+}, Mg^{2+}, K^+, Na^+ and NH_4^+) and anions (NO_3^-, NO_2^-, SO_4^{2-}, Cl^-, HCO_3^- , P_i), TP, TN, EC and total hardness in water were assayed according to APHA (2005).

Estimation of biological concentration factor (BCF)

Biological concentration factor (BCF) values for algae were calculated using the metal concentration in the organism with respect to dry weight and the total metal concentration in the surrounding water as the following formula.

$$\mathrm{BCF} = \frac{\text{Metal concentration in the organism}}{\text{Metal concentration in the surrounding water}}$$

Estimation of algal biochemical and phytochemical composition

Total soluble sugars (TSS) and total soluble proteins were estimated as described by **Schortemeyer *et al.* (1997**) and **Bradford (1976**), respectively and they were expressed as mg glucose/protein g DW^{-1}; glucose/bovine serum albumin was used as the standard material, respectively. The phytochemical screening of different algal extracts was assessed by standard method as described by **Savithramma *et al.* (2011)**. Lipid was estimated using chloroform: methanol (2:1, v/v) as described by **Bligh and Dyer (1959**).

Statistical analysis

The data of Physico-chemical properties were subjected to one-way ANOVA using SPSS v 22 at significant level of $p \leq 0.05$.

Results

Physicochemical properties of water

The result of water physicochemical properties exhibited a wide-ranging of spatial variations at S1 compared to S2, where most of Physico-chemical properties showed very highly significant variations at $p \leq 0.001$, except Ph. Ph. Alk, T Alk and TN that showed non-significant variations (**Table 1**). It is noticeable that Port Saied (S2) gave the higher values of water properties compared to Ras El-Bar station (S1), particularly TDS (54.6 to 0.77 g/L), EC (161.7 to 1.2 mmhos/cm) and Cl^{-1} (22 to 0.14 g/L), this indicated that S2 is marine water whereas S1 is freshwater. However, water pH values exhibited a wide range of local variation between 7.7 at S1 and 9.5 at S2 (at $p \leq 0.001$).

Whereas Temp, DO, BOD, CO_2, NO_2, PO_4, TPO_4, and Fe, increased significantly by 10%, 6.9 fold, 7 fold, 1.4 fold, 11.5 fold, 12 fold, 4.2 fold, 1.7 fold, respectively at S1 compared to those at S2, Temp, DO, BOD, CO_2, NO_2, PO_4, TPO_4 and Fe decreased significantly by 9.5 %, 87%, 87.5 %, 58%, 92 %, 92 %, 80.6% and 63%, respectively at S2 compared to those at S1(**Table 1**).

Again, pH, TDS, EC, total Hardness, Ca Hard, Mg Hard, Cl^{-1}, T Alk., COD, NH_4, NO_3, Na^+, K^+, Ca^{2+}, Cu, Co and Cd increased significantly by 23 %, 70 fold, 133 fold, 28 fold, 46 fold, 16 fold, 155 fold, 32 fold, 1.5 fold, 83%, 92 fold, 5 fold, 32 fold, 34%, 2.4 fold and 88% in S2 than S1. Conversely, pH, TDS, E.C, T Hardness, Ca. Hard, Mg. Hard, Cl, T Alk., COD, NH_4, NO_3, Na^+, K^+, Ca^{2+}, Cu, Co and Cd decreased significantly by 19%, 99%, 99%, 97%, 98%, 94%, 99%, 38%, 97%, 60%, 45%, 99%, 84%, 97%, 25 %, 71% and 47% in S1 than that at S2. (**Table1**). Finally, DO concentration varied between the higher value (8.22 mg L^{-1}) at S1 and the lower value (4.42 mg L^{-1}) at S2.

The dissolved oxygen decreases gradually during the second half of the night until complete depletion of DO from water.

Table 1: Physicochemical properties of water samples taken from the study sites. Data are means ± SE (n = 3)

Parameters	S1	S2	*P*
Temperature (°C)	24.67 ± 0.333	22.33 ± 0.333	$p \leq 0.05$
pH	7.71 ± 0.003	9.51 ± 0.030	$p \leq 0.001$
E.C. (mmhos/cm)	1.21 ± 0.0007	161.67 ± 0.882	$p \leq 0.001$
TDS (g /L)	0.772 ± 0.577	54.60 ± 0.577	$p \leq 0.001$
Salinity (%)	3.4 ± 0.2	38 ± 0.8	$p \leq 0.001$
Chloride (g /L)	0.14 ± 0.000	22.11 ± 0.8	$p \leq 0.001$
T Alk. (mg /L)	160 ± 0.000	260 ± 0.000	ns
Ph.ph. alkalinity	Zero	120 ±0.000	ns
CO_2 (mg /L)	126.1 ± 2.93	52.80 ± 5.08	$p \leq 0.001$
DO (mg /L)	8.22 ± 0.000	4.42 ± 0.173	$p \leq 0.001$
BOD (mg/L)	5.42 ± 0.067	0.677 ± 0.178	$p \leq 0.001$
COD (mg /L)	24 ± 0.000	800± 0.000	$p \leq 0.001$
Ca Hardness (mg/L)	2.733 ± 0.035	128.3 ± 1.67	$p \leq 0.001$
Mg Hardness (mg /L)	4.05 ± 0.233	66.33 ± 1.85	$p \leq 0.001$
T Hardness (mg /L)	6.78 ± 0.194	194.67 ± 0.333	$p \leq 0.001$

Ammonia (mg/L)	0.914 ± 0.137	2.28 ± 0.089	$p \leq 0.001$
Nitrite (mg/L)	0.042 ± 0.0003	0.003 ± 0.0007	$p \leq 0.001$
Nitrate (mg/L)	0.954 ± 0.07	1.74 ± 0.016	$p \leq 0.001$
Organic Nitrogen (mg /L)	4.350 ± 0.972	1.400 ± 0.367	$p \leq 0.05$
T N (mg /L)	6.252 ± 0.526	5.419 ± 0.196	ns
Orthophosphate (mg/L)	0.048 ± 0.0007	0.004 ± 0.0007	$p \leq 0.001$
T P (mg/L)	0.095 ± 0.0003	0.018 ± 0.0009	$p \leq 0.001$
Na (mg/L)	128.055 ± 2.52	11942 ± 246.24	$p \leq 0.001$
K (mg/L)	29.66 ± 0.32	186.71 ± 2.811	$p \leq 0.001$
Ca (mg/L)	5.798 ± 0.11	191.30 ± 1.29	$p \leq 0.001$
Fe (mg/L)	0.29 ± 0.004	0.11 ± 0.0006	$p \leq 0.001$
Cu (mg/L)	0.042 ± 0.0006	0.059 ± 0.0009	$p \leq 0.001$
Co (mg/L)	0.24 ± 0.014	0.817 ± 0.005	$p \leq 0.001$
Cd (mg/L)	0.008 ± 0.0006	0.015 ± 0.0006	$p \leq 0.001$

Significant $p \leq 0.05$, highly significant $p \leq 0.01$, very high significant $p \leq 0.001$- ns: non- significant

Table 2: Dissolved oxygen content at different water level during 24h (day and night)

Time (h)	**Normal fresh water**			**Ras El-Bar freshwater pond**		
	Surface	Middle	Bottom	Surface	Middle	Bottom
6-8	6.9	6.1	5.5	3.15	2.2	2.1
8-10	8.1	7.2	5.6	4.3	3.5	2.1
10-12	8.2	7.2	5.8	4.8	3.0	2.1
12-4						
12-14	9.2	7.3	6	5.1	2.1	1.4
14-16	8.1	7.4	6.2	5.1	2.5	1.3
16-18	7.9	7.2	5.8	5.1	2.2	1.1
18-20	7.6	6.8	5.6	4.8	2.1	0.8
20-22	6.9	6.4	5.1	4.8	1.2	0.5
22-24	5.9	5.8	4.7	4.1	1.2	0.3
24-2	5.5	5.1	4.5	2.13	0.6	0.16
2-4	5.2	4.8	4.3	1.9	0.18	0.08
4-6	4.9	4.6	3.9	1.18	0.10	0.01

Time (h)	**Normal marine water**			**Port Saied marine water pond**		
	Surface	Middle	Bottom	Surface	Middle	Bottom
6-8	6.4	5.6	4.9	5.65	4.7	4.1
8-10	7.8	6.8	5.2	6.8	5	4.6
10-12	7.6	6.8	5.4	7.3	5.1	4.7
12-4						
12-14	8.4	7.1	5.8	8.8	5.6	4.8
14-16	8	7.3	6.1	9.4	6.1	5.3
16-18	7.8	6.9	5.6	9.9	5.8	5.0
18-20	7.3	6.8	5.3	7.9	4.8	4.1
20-22	6.8	5.6	4.9	6.9	3.7	3.2
22-24	5.8	5.13	4.5	5.9	2.5	1.5
24-2	5.4	4.8	4.4	4.8	1.2	0.9
2-4	5.3	4.6	4.1	3.9	0.6	0.1
4-6	4.8	4.1	3.19	2.6	0.2	0

Algal Biochemical Composition

The starch and lipid ($p \leq 0.05$ and $p \leq 0.001$, respectively) content was significantly higher in *Ch. vieillardi* than that in *C. glomerata* by 30% and 53%, respectively, TSS ($p \leq 0.05$) content was significantly higher in *C. glomerata* than that in *Ch. vieillardi* by 68%. However, protein content was non-significant (comparable) in both *C. glomerata* and *Ch. vieillardi* (**Table 3)**. The content of Fe ($p \leq 0.01$), Co and Cd ($p \leq 0.001$) significantly increased by 6%, 105% and 83%, respectively in *C. glomerata* than that in *Ch. vieillardi*. However, the content of Na, K, Ca and Cu ($p \leq 0.001$) increased significantly by 60 fold, 40 fold, 40 fold and 4 fold respectively, in *Ch. vieillardi* than that in *C. glomerata* (**Table 3**).

Table 3: Biochemical composition of *C. glomerata* and *Ch. vieillardi* and BAF, Data are means ± SE (n = 3)

Parameters	*C. glomerata*	*Ch. vieillardi*	*P*
Protein (mg g DW^{-1})	6.66 ± 0.45	7.50 ± 0.54	ns
TSS (mg g DW^{-1})	15.45 ± 1.27	9.18 ± 0.90	$p≤0.05$
Starch (mg g DW^{-1})	38.97 ± 1.78	50.65 ± 4.6	$p≤0.05$
Lipids (mg g DW^{-1})	19.00 ± 0.06	29.00 ± 0.06	$p≤0.001$
Na (mg g DW^{-1})	0.15 ± 0.013	9.103 ± 0.14	$p≤0.001$
K (mg g DW^{-1})	0.495 ± 0.02	20.43 ± 0.17	$p≤0.001$
Ca (mg g DW^{-1})	0.23 ± 0.009	9.39 ± 0.062	$p≤0.001$
Fe (mg g DW^{-1})	1.18 ± 0.006	1.11 ± 0.003	$p≤0.01$
Cu (mg g DW^{-1})	0.055 ± 0.0009	0.277 ± 0.003	$p≤0.001$
Co (mg g DW^{-1})	3.54 ± 0.067	1.73 ± 0.032	$p≤0.001$
Cd (mg g DW^{-1})	0.19 ± 0.004	0.10 ± 0.00	$p≤0.001$
BCF (Fe)	4.13	10.50	
BCF (Cu)	1.33	4.93	
BCF (Co)	14.92	2.12	
BCF (Cd)	24.24	6.98	

Biological concentration factor (BCF)

Ch. vieillardi accumulates Fe, Cu, Co and Cd in its cells by approximately 11 fold 5 folds, 2 folds and 7 fold, respectively more than that in seawater versus to approximately 4 folds, 1.3 folds, 15 fold and 24 folds, respectively in *C. glomerata* (**Table 3**). The calculated BCF exhibited that *Ch. vieillardi* uptakes metals in the order of Fe □ Cd □ Cu □ Co compared to Cd □ Co □ Fe □ Cu in *C. glomerata*.

Phytochemical composition

The results showed remarkable variations in the type and concentration of phytochemical compound between *Ch. vieillardi* and *C. glomerata* (**Table 4**). Whereas tannins, phenols and quinones are absent in both *Ch. vieillardi* and *C. glomerata*, yet flavonoids and coumarins are equivalent in both them. While saponins are present in *C. glomerata*, but not in *Ch. Vieillardi*, glycosides are present in *Ch. vieillardi*, but not in *C. glomerata*. Terpenoids and steroids were higher in *C. glomerata* compared to *Ch. vieillardi*. On the contrary, alkaloids were lower in *C. glomerata* compared to *Ch. vieillardi*.

Table 4. Qualitative analysis of phytochemical substances in *C. glomerata* and *Ch. vieillardi*

	Test	*C. glomerata*	*Ch. vieillardi*
1.	**Alkaloids**	+	++
2.	**Terpenoids**	++	+
3.	**Steroids**	++	+
4.	**Tannins**	-	-
5.	**Saponins**	+	-
6.	**Flavenoids**	+	+
7.	**Phenols**	-	-
8.	**Coumarins**	+	+
9.	**Quinones**	-	-
10.	**Glycosides**	-	+

Discussion

Physico-chemical properties of water

The significant variation in Physico-chemical properties of water confirmed that *C. glomerata* inhabits freshwater whereas *Ch. vieillardi* prefers to inhabit marine water. This agree with the results of **Tsutsui *et al.* (2015)** who reported that *Chaetomorpha* inhabits salinities of 3.4–90.0%. The freshwater pH value (7.7) maybe suitable to the excessive growth of *C. glomerata* according to the study range of **Messyasz *et al.* (2015)** who reported that pH range for *Cladophora* massive development ranged between 7.8 and 8.3. In addition **Xu *et al.* (2009**) confirmed that the growth of *Ch. valida* increased with increasing the range of pH from 6.5 to 8.5. Also, the growth and photosynthetic activity of algae are closely tied to the temperature, pH, salinity, and other environmental factors (**Fu 2014**).
The high concentration of DO at S1 (8.22 mg L^{-1}) could be attributed to the high content of *Chl a* (**Smith and Piedrahita 1988)** of *C. glomerata bloom*, besides, Increasing the solar radiation that is favorable for photosynthesis, increase the DO concentration producing from algal blooms during the day (**Sánchez *et al.* 2007**), this indicates that *C. glomerata* could favor clean freshwater (ultra-oligotrophic) at Ras El-Bar freshwater pond. Whereas the lower

DO concentration at S2 (4.42 mg L^{-1}), even though massive growth of *Ch. vieillardi*, may be due to the decrease in oxygen solubility with increasing salinity (**Mountford 1969**), this signifies that *Ch. vieillardi* could prefer polluted saline water (hyper-eutrophic status). Since the insufficient dissolved oxygen (<2 mg L^{-1}) will occur at very low or very high concentrations of *Chl a* (**Smith and Piedrahita 1988)**, therefore, water quality and trophic status were ranged between moderate pollution (mesotrophic) at S1 and very polluted water (hyper-eutrophic) at S2.

The high values of BOD and considerable values of COD at S1 compared to S2 may be attributed to the increase of photosynthetic organisms that produce an additional oxygen during the decomposition of dead biomass (**Sánchez *et al.* 2007)**. Whereas the very high values of COD at S2 probably due to the relative high water pollution and the oxidative of the organic matter (pollutants and dead algal biomass). These leads to the reduction of dissolved oxygen concentration and the increase in oxygen deficit (**Sánchez *et al.* 2007)**. Furthermore, BOD/COD ratio at S1 (Ras El-Bar fresh water pond) equals 0.22 versus to 0.0009 at S2 (Port Saied marine water pond), this signifies that Damietta Ras El-Bar fresh water is in a biodegradable range (between 0.1 and 1.0) as described by **Samudro** and **Mangkoedihardjo (2010**). However, the decreased ratio of BOD/COD at Port Saied marine water pond could be attributed to high water pollution and high salinity of seawater (**Mehrdadi *et al.* 2006).**

The present studies revealed that the dissolved oxygen content at study area decreased gradually during night toward bottom. Moreover, the DO at middle and bottom level of water recorded very low values or relatively depletion. These mainly due to the stop production of DO at the second half of night and in the same time, the consumption of DO through BOD and COD continued. Consequently, the DO of water decreased to very low level (relatively zero) (**Kibria 2004**).

The decreased of DO at two water ponds which containing massive growth of *Cladophora* and *Chaetomorpha* resulting in high loss of aquatic aquacultures production (Fish production) **(Boyd and Hanson 2015)**.

The significant increase in NO_2, Organic N, TN and TP concentrations and decrease in NH_4 and NO_3 in S1 may be attributed to that some NH_4-N and NO_3 could be incorporated into organic nitrogen by the algae, increasing TN where N within the dead algae cannot be dissolved back into the water completely without the de-nitrification process (**Li *et al.* 1991**). The ratio of N:P at S1 and S2 were (66:1 and 300:1, respectively) more than the optimum N: P ratio which is favorable to the algae growth and their uptake of P according to **Li *et al.* (1991**) who reported that the optimum ratio of N: P is 5:1.

The decrease in P concentration that concomitant with increased pH at S2 compared to S1 could be attributed to the algal photosynthesis increases pH that promotes the removal of P through precipitation. Although algae can use organic and inorganic P, they mainly depend on inorganic P and convert it into organic P for themselves, which will be partly released back to the surrounding water and then settle to the bottom of the aquatic system when they die (**Li *et al.* 1991**).

The significant increase in TSS content and decrease in starch and lipid content of freshwater *C. glomerata* compared to marine *Ch. vieillardi* could be attributed to water salinity effect (**Chaves and Oliveira 2004)**. This suggests that *Ch. vieillardi* could be a source of biodiesel production as well as carbohydrate. Meanwhile, the higher content of Na, K and Ca in *Ch. vieillardi* compared to *C. glomerata* could be attributed to that *Ch. vieillardi* has the ability to accumulate essential mineral elements (**Aziza *et al.* 2014)**.

The higher content of Fe, Co and Cd in *C. glomerata* compared to *Ch. vieillardi*, the reverse was true for Cu. This suggests that freshwater *C. glomerata* has the ability to accumulate high content of heavy metals more than marine *Ch. vieillardi*. This partially agrees with the findings of **Aziza *et al.* (2014)** who reported that algae have the ability to accumulate heavy metals. The significant difference in physicochemical characteristics of habitats might be responsible for the variance in chemical composition of *Ch. vieillardi* compared to *C. glomerata*.

Heavy metals and BCF

The increased BCF values in *C. glomerata* and *Ch. vieillardi* with decreasing metal concentration in the surrounding medium could be attributed to that *C. glomerata* and *Ch.*

vieillardi cells have high negative surface charge that attract heavy metal cations (**Rao *et al.* 1986**). *Ch. vieillardi* effectively accumulates Fe and Cu versus Co and Cd in *C. glomerata*. This means that the heavy metal accumulation from the surrounding medium did not equal for all organisms and for all metals (**Canterford *et al.* 1978**). This suggests that the selectivity of heavy metals accumulation in *C. glomerata* or *Ch. vieillardi* could be used as a means of removing metals from heavy metal polluted water and industrial effluents. The decrease of heavy metal concentration in Ras El-Bar freshwater compared to marine water could be attributed to that *Cladophora* is an ancient biosorbent of some heavy metals (**Lee and Chang 2011**), because the polysaccharides with ion-exchange properties in its cell wall can bind with heavy metals (**Żbikowski *et al.* 2007**). Therefore, *C. glomerata* could be the most proper bio-indicator of heavy metals in aquatic bodies (**Borowitzka and Borowitzka 1988**).

Conclusion

The dissolved oxygen content at study area decreased gradually during night toward bottom. Moreover, the DO at middle and bottom level of water recorded very low values or relatively depletion. The decreased of DO at two water ponds which containing massive growth of *Cladophora* and *Chaetomorpha* resulting in high loss of aquatic aquacultures production. The variance of *Ch. vieillardi*and*C. glomerata* phytochemical and biochemical composition could be attributed to the difference in the physicochemical properties of their habitats. *Ch. vieillardi* has higher carbohydrate and lipid content compared to *C. glomerata*. Meanwhile heavy metal concentration in freshwater was more than that in marine water except Cu, yet Fe and Cu were highly accumulated by marine *Ch. vieillardi* versus Cd and Co by freshwater *C. glomerata*.

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الملخص العربي

عنوان البحث:

سهام أبو أحمد[١]، محمد دياب[١]، رضوى الشنواني[١]، ماجدة العدل[١]
[١] قسم النبات والميكروبيولوجي، كلية العلوم ، جامعة دمياط ، مدينة دمياط الجديدة ، مصر

هذه الدراسة تهدف إلى المقارنة بين نوعين من الطحالب ، طحلب الكيتومورفا الذى يعيش فى المياه المالحة وطحلب الكلادفورا الذى يعيش في المياه العذبة. تم تجميع عينات المياه والطحالب من بركة مياه مالحة ببورسعيد وبركة مياه عذبة في رأس البر في

عام ٢٠١٩.

نجد أن النموات العالية للطحلبين والمتكونة نتيجة لتوافر الظروف المناسبة في هذه الأماكن من ظروف بيئية أو الحالة الغذائية المناسبة للكائن تتسبب في مشاكل بيئية واقتصادية.

هذه النموات العالية من الطحلبين تتسبب في الانتزاع الكامل للأكسجين الذائب في منتصف وقاع سطح المياه في النصف الثاني من الليل.

يتسبب الفقد في الأكسجين في فقد هائل في بيئة الأحياء المائية . على الرغم أن هذين الطحلبين ينتميان لنفس العائلة إلا أن أنهم يفضلان بيئات مختلفة فطحلب الكيتومورفا يفضل تكوين تجمعات فى المياه المالحة أما طحلب الكلادفورا يفضل تكوين تجمعات في المياه العذبة.

يؤدى كل من التنوع في التركيب الكيميائي والنباتي وكذلك قدرة كل من الكيتومورفا والكلادفورا على تراكم العناصر الثقيلة بداخلها إلى الاختلاف في الخصائص البيولوجية وكذلك في الظروف المناسبة لنمو كل كائن.

وأخيرا نجد أن المحتوى الكربوهيدراتى والدهني لطحلب الكيتومورفا أعلى من طحلب الكلادفورا وفى الوقت نفسه قدرة طحلب الكلادفورا على تراكم العناصر الثقيلة بداخله أعلى من طحلب الكيتومورفا ما عدا عنصري النحاس والحديد واللذان يتراكمان بمعدل أعلى في طحلب الكيتومورفا.