ISSN: 2347-5129
(ICV-Poland) Impact Value: 5.62
(GIF) Impact Factor: 0.352
IJFAS 2016; 4(1): 259-263

www.fisheriesjournal.com
Received: 10-11-2015
Accepted: 12-12-2015

Abeer M.A. Mahmoud
National Institute of Oceanography and Fisheries, Fish Research Station. El-Kanater El-Khayria, Cairo, Egypt.

Correspondence
Abeer M.A. Mahmoud
National Institute of Oceanography and Fisheries, Fish Research Station. El-Kanater El-Khayria, Cairo, Egypt.

Regional and seasonal variation of biochemical contents of phytoplankton in El-Rayah Al-Nasery and El-Rayah Al-Behery Nile River Egypt

Abeer M.A. Mahmoud

Abstract
The phytoplankton biochemical composition considered as a biomarker of the ecosystem of different sites in River Nile. So the present study investigated the spatial and temporal variations of the biochemical contents of the phytoplankton during 2014 at different stations of El-Rayah Al-Nasery and Al-Behery in River Nile, Egypt. In the tow Rayahs, the crude protein constitutes the major part of the biochemical contents of the phytoplankton while the total lipid constitutes the minor one. There is a direct relationship between the biochemical contents and the physiochemical and environmental conditions including nutrients especially nitrates and phosphates.

Keywords: Phytoplankton biochemical composition, El-Rayhat, Physiochemical and environmental conditions, Nutrients.

1. Introduction
Phytoplankton represents primary producers of organic matter, which provide the food base for most marine and freshwater food chains and play an important role in the equilibrium of aquatic ecosystem (Reference) [13]. Also microalgae can use for the production of biomass as a health food (Reference) [31]. Some blue-green microalgae were a source of phycocyanin pigment, which has highly commercial uses in food colorant, cosmetic and pharmaceutical industries (Reference) [4]. Other uses, they can use as water bioremediation agents (Reference) [21], to feed fish fry in aquaculture (Reference) [32] and has been considered to be an important subject for biotechnological research due to its economical, ecological and nutritional importance (Reference) [23].
All algae primary comprises of the following in varying proportions: proteins, carbohydrate, and lipid. While the percentages vary with the type of algae, there are algae types that are comprised up to 40% of their overall mass by fatty acids (Reference) [7]. Algae oil has been produced for the cosmetic industry and interest in making Biodiesel. Another algae type that are edible microorganism, useful in nutrition due to the high quantity and quality of its protein content.
This study investigated that the regional and seasonal variation affected the biochemical content of phytoplankton during four seasons (spring 2014, summer 2014, autumn 2014 and winter 2015) at different stations in El-Rayha Al-Nasery and Al-Behery (River Nile, Egypt)

2. Materials & Methods
The study site
The Nile River bifurcates at El Kanater City to two main branches (Damietta and Rosetta branches) and four Rayahs (Rayah are the main irrigation Canals in Egypt). The Rayahs include El Rayah El Tawfiki, El Rayah Menoufy, El Rayah Al-Behery and El Rayah Al-Nasery. In the present study 8 stations at El Rayah Al-Nasery and 9 stations at El Rayah Al-Behery were selected (Fig 1). Details of the sampling locations with their longitude and latitude are presented in Table 1.

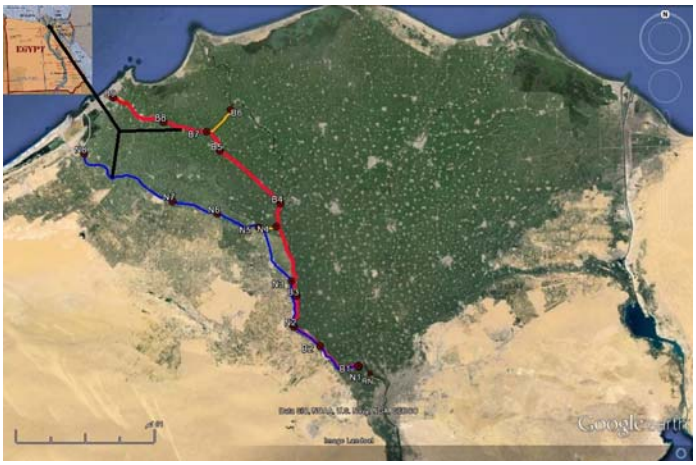

Fig 1: Map of the study area indicates the sampling locations (Goher. 2015)

3. The sampling location of El-Rayahs

Phytoplankton sampling

Water samples were collected from each station in plastic bottles, then filtered 10 ml by Whatman GF/F fiber circles, for the biochemical analysis.

El-Rayah Al-Nassery

El-Rayah Al-Nasary starts from Rosetta branch at El-Kanater El- Khayria city and extends parallel to El-Rayah Behery in the West of Delta, where is heading northwest in the direction of Noubaria canal which across from El-Rayah Behery.

El-Rayah Al-Nasery meets with Noubaria canal at Kanater Pauline (at Koum Hamada) and then heading to the northwest even Mediterranean Sea breaking Mariout Lake. It extends to the right of Rayah many of villages while on the left side there are many of agricultural land reclamation, it also a distinct course of navigation, especially across Noubaria Canal. The length of this Rayah is about 200 Km starting from El-Kanater El-khairia city with average width 40-50 m and its average depth 2-5 m.

El-Rayah Al-Nasery is characterized (just like the other Rayahs) by the existence of many drinking water plants and electrical power plants on the two banks, especially around El Noubaria Canal. For example, the giant Drinking Water Plants are Abu El Matameer, Mariout (1) and Mariout (2). The water sample stations that have been collected from this Rayah were eight stations (N1-N8) (Reference) [15].

Table 1: Details, longitude and latitude of the sampling locations

St.No	Name	Latitude	Longitude	Distance
RN	River Nile	30°10'20.72"	31° 8'23.98"	1.5 km
El Rayah Al-Nasery				
N1	El Kanater	30°10'36.78"	31° 6'29.77"	2Km
N2	El-Khatatba	30°19'57.76"	30°48'57.5"	45Km
N3	Koum Hamada	30°30'31.3"	30°48'18.6"	80Km
N4	El-Noubaria 1	30°42'51.0"	30°44'26.8"	90Km
N5	El-Noubaria 2	30°43'44.69"	30°33'47.14"	87-90Km
N6	Itai El-Baroud	30°49'4.75"	30°14'57.56"	135Km
N7	Housh Issa	30°54'38.06"	30° 2'9.52"	170Km
El Rayah El Behery				
N8	The end of Nubaria	30°59'54.76"	29°51'49.97"	200Km
B1	El Kanater	30°10'47.36"	31° 6'18.69"	2Km
B2	Abo Ghaleb	30°14'46.90"	30°56'33.68"	30Km
B3	Kaffr Dawood	30°27'3.75"	30°49'41.35"	65Km
B4	El-Tawfikia	30°48'36.91"	30°45'21.65"	90-100Km
B5	Damanhour 1	31°00'46.5"	30°28'52.8"	135Km
B6	El-Mahamoudiah	31°10'25.9"	30°31'42.1"	140Km
B7	Damanhour 2	31° 5'16.85"	30°25'16.79"	145Km
B8	Kaffr El-dawar	31° 7'31.58"	30°13'31.82"	180Km
B9	El-Siuof (Alexandria)	31°13'6.67"	29°59'39.74"	210Km

*After Goher, 2015

El-Rayah Al- Behery

El-Rayah Al-Behery starts from the Rosetta branch at El-Kanater El- Khayria city and extends into the West of Delta, heading the north-west parallel to Rosetta branch and west of Giza Governorate. It passes in Nekla, Abu Ghalib and Khatatba cities and then through Beheira Governorate and also, it passes into Kafr Daoud, Kom Hamada, Itai El Baroud, Damanhur, Kafr El Dawar cities then Alexandria Governorate.

El-Rayah Al-Behery confluences with El Mahmudiyah canal after Damanhur city (El Mahmudiyah canal is a branch from Rosetta branch at El Mahmudiyah city). This segment is heading to the northwest until it reaches to Alexandria city, this a part of Rayah is taking name (El Mahmudiyah canal) after concordance even Alexandria that a part is an important nautical stream.

The length of this Rayah is about 220 Km or more starting from El-Kanater El- Khayria city to Alexandria with average width 40-50 m and its average depth 2-3m.

El-Rayah Al- Behery is characterized (just like the other Rayahs) by the existence of many drinking water plants and electrical power plants on the two banks, especially on El Mahmudiyah canal that supply water to Beheira and Alexandria governorates. For example the giant drinking water plants are Kafr El Dawar, El Siuf and Abis, in addition to some small drinking water plants. Nine stations (B1-B9) were selected along this Rayah were. The names and locations of these stations are presented in the following (Reference) [15].

4. Biochemical analysis

The crude protein

The total protein of algal tissue is determined by Biuret method (Reference) [11]. Copper in alkaline medium reacts with a peptide bond of protein giving blue color, read on Spectronic at 550 nm.

Total cellular carbohydrate

The hydrolysis of carbohydrate was carried out by Reference [19] and determined by the phenol sulphuric acid method as described by Reference [12] using glucose as a standard.

Total lipid

Total lipid contents were determined by the sulfo phospho vanillin procedure (SPV). This method was first published by Reference [10]. The absorbance of the characteristic pale pink color was measured by Spectronic at 525 nm, using Cholesterol as a stander.

5. Results & Discussion

The present data indicated that there are a large different types of algal community due to the large different amount of biochemical contents; crude protein, total cellular carbohydrate and total lipid. Also Reference [16] found that, there is large variation of biochemical levels in the algae between species and location.

El-Rayha Al-Nasery

In spring 2014, the maximum protein content found at station 7, with the value of (25.15 mg/L), while the minimum protein content is at station 3, with the value of (6.14 mg/L) [Fig *2*]. The nutrients, especially the nitrates (NO_3) and phosphate (PO_4) indicated the fertility of the water to increase and enrichment of the biochemical contents, so at station 7 the level of nitrate and phosphate were recorded; 127.36 µg/l and 13.28 µg/l respectively, while at station 3, they were 98.51 µg/l and 9.92 µg/l respectively (Reference) [15]

The highest crude protein content was detected in summer 2014, (173.93 mg/L) [Fig 2]. In this season, the maximum level of nitrate and phosphate were 194.4 µg/l and 79.65 µg/l respectively. While, the lowest protein content was obtained in autumn 2014, (3.07 mg/L) at station 4 [Fig 2], at the same time, the lowest nitrate was at station4 (22.45µg/l) in autumn 2014. This contrariety with Reference [20], who mentioned that high water temperature has been related to decrease the crude protein content. While the negative correlation between nutrient and some other phytoplankton species may be due to increased utilization of such nutrients by these phytoplankton species (Reference) [30]. Reference [29] fond that the nutrient-phytoplankton relationships in the River Nile include a possible limitation by low concentrations of inorganic nitrogen in determinations of photosynthetic productivity which effect on the total cellular carbohydrate content. Other studies found that higher pollution and high concentration of nutrients affected the phytoplankton in Damietta Branch (Reference) [2], Helwan Region of River Nile (Reference) [28] and in Lake Manzala (Reference) [27].

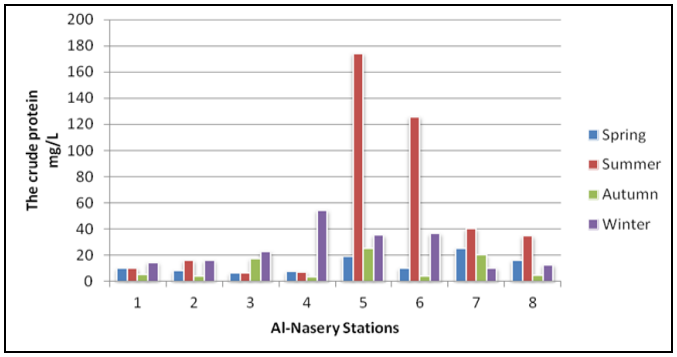

Fig 2: The crude protein (mg/L) of phytoplankton at Al-Nasery Stations

Carbohydrates in microalgae found in the form of starch, glucose, sugars and other polysaccharides (Reference) [7].The maximum carbohydrate content was at station 5 (1.4 mg/L), in summer 2014, while the minimum value was at station 7 (0.1 mg/L), in autumn 2014 [Fig 3]. This agrees with Reference [1], they found that, the maximum level of total carbohydrate concentration was found in summer, while the minimum level detected in autumn. Reference [3] found that carbohydrates constitute the major part of the biochemical contents of epiphytic microalgae in Lake Bardawil.

In summer 2014, there are intermediate levels of nutrients, the average nitrate and phosphate nutrients were 72.32 µg/l and 33.72, µg/l respectively (Reference) [15] these nutrients caused enrichment in the total cellular carbohydrate. Reference [18] found that, the highest species richness was found at sites with intermediate levels of nutrient enrichment.

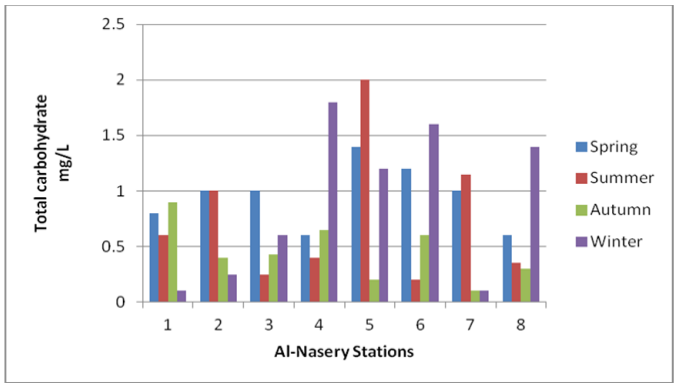

Fig 3: Total carbohydrate (mg/L) of phytoplankton at Al-Nasery Stations

Algal lipids are composed of glycerol, saturated and unsaturated fatty acids, some fatty acids of ω3 & ω6 families are pharmaceutically importance (Reference) [17]. Reference [14] observed that algae can directly produce highly unsaturated fatty acids (HUFA). In the present study, the total lipid content of phytoplankton reached maximum in summer 2014, with the value of 1.42 mg/L, while the minimum value 0.08 mg/L was in winter 2015, [Fig 4]. At the same time, the total phosphorus recorded the maximum value in summer 2014, (79.65 µg/l), while the minimum value was 2.23µg/l in winter 2015, Reference [15].

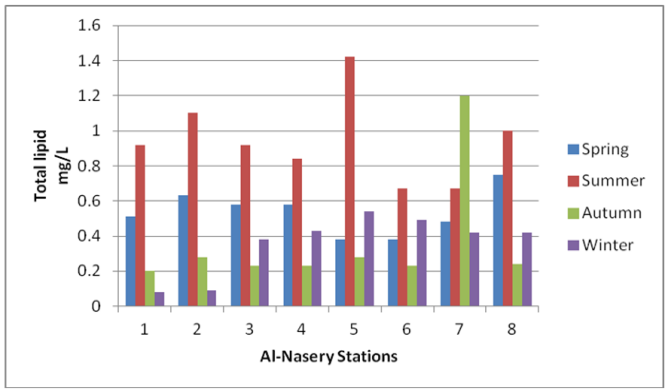

Fig 4: Total lipid (mg/L) of phytoplankton at Al-Nasery Stations

In El-Rayah Al-Nasery the maximum yield of all biochemical contents; crude protein, total carbohydrate and lipid obtained in summer 2014, while the minimum yields were in autumn 2014, and winter 2015.

El-Rayah Al-Behery

The biochemical composition of phytoplankton populations is influenced by spatial and temporal changes in environmental parameters including light, temperature and nutrients (Reference) [24], [6]. In the present study, the biochemical composition of phytoplankton populations is influenced by the seasonal and regional variations, in addition; the concentration of nutrients, especially, nitrate and phosphate strongly affected the biochemical contents of the phytoplankton. The highest values of crude protein and total lipid obtained in autumn 2014 [52.76 mg/L, at station 9 & 1.76 mg/L, at station 8 respectively] Fig. 5&7, while the lowest value of crude protein and total lipid were in summer 2015 [1.23 mg/L, and 0.08 mg/L, respectively], Table 5&7. This strongly agrees with nutrient concentration; the highest value of nitrates during the four seasons was detected in autumn with the value of 2100.99 µg/l, at the station of highest crude protein (station 9) while the lowest value was (10.44 µg/l) in summer, Reference [15].

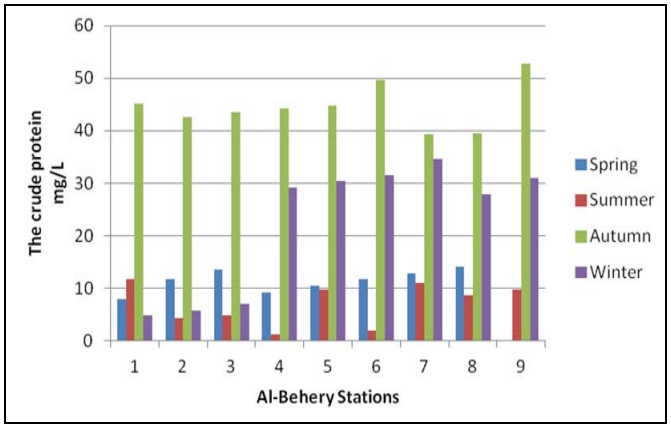

Fig 5: The crude protein (mg/L) of phytoplankton at Al-Behery Stations

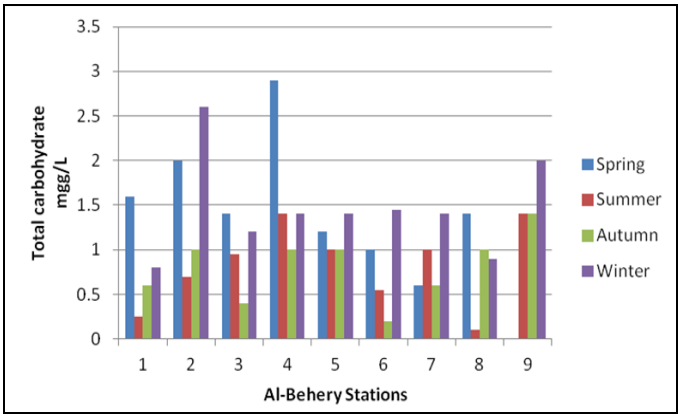

Fig 6: Total carbohydrate (mg/L) of phytoplankton at Al-Behery Stations

The maximum carbohydrate content was at station 4 (2.9 mg/L), in spring 2014, while the minimum value was at station 6 (0.2 mg/L), in autumn [Fig 6]. Reference [15], found that nitrate concentration at station 4 in spring 2014 was 134.16 µg/l, while at station 6, in autumn there are high concentrations of nitrate and phosphate (1983.27 µg/l & 129.3 µg/l respectively) and at the same time high quantity of the crude protein (49.7 mg/L). Carbohydrates and protein serve both as structural and storage components and represent the major form of photo chemically assimilated carbon in the biosphere and are powerful tools in the pathways of biologically important organic materials in nature (References) [5, 22, 9]. The ratio carbohydrates/lipids were used as an indicator of the chemical quality of the plankton (Reference) [26].

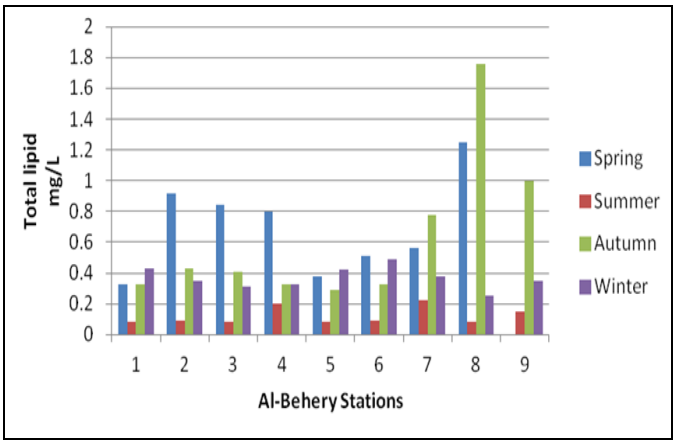

Fig 7: Total lipid (mg/L) of phytoplankton at Al-Behery Stations

In El-Rayah Al-Behery the maximum yield of crude protein, and total lipid obtained in autumn 2014, while the minimum yields were in summer 2014, while the maximum yield of carbohydrate was in spring and the minimum one was in autumn.

In El-Rayah Al-Nasery & Al-Behery the crude protein constitutes the major part of the biochemical contents of the phytoplankton while the total lipid constitutes the minor one. This agrees with Reference [25], who conducted that the tested microalgae had protein as the main chemical component (31.5-64.1% dry weight), with lower amount of lipid (8.0-21.7% dry weight). Also Reference [1], conducted that protein constitutes the major part of the biochemical contents of the phytoplankton of Ismailia Canal while lipid constitutes the minor one According to Anova and Correlation statistical analysis, the total protein in El-Rayah Al-Behery show high temporal_significant difference $p< 0.001$, total carbohydrate, show high temporal significant difference $p< 0.01$ and total lipid, show high temporal significant difference $p< 0.01$ [temporal = between the seasons]. There are not spatial difference [spatial = between the stations]. In El-Rayah Al-Nasery, only total lipid, show high temporal significant difference $p< 0.001$. Also in El-Rayah Al-Behery, total protein showed positive correlation with nitrates ($r = 0.54$) and total lipid showed positive correlation with phosphates ($r = 0.5$). While, in El-Rayah Al-Nasery, only the total lipid showed positive correlation with phosphates ($r = 0.57$).

6. Conclusion & Recommendation

The results indicated that the phytoplankton biochemical compositions of El-Rayahat in River Nile are variable during the four seasons, according to the physicochemical conditions including, nutrients especially, nitrates & phosphates, and the environmental conditions including the sites of studying.

It is strongly recommended according to our data the importance of mass production of different algae for exploitation its valuable biochemical components. The high protein contents needed for formulating artificial food. On the other hand, the exploitation of the natural protein of algae as a source of protein for the artificial fish meal production is essential to protect the aquatic environment from the adverse impact of fish meal and meat meal that widely used as a source of protein. Also the present study providing the importance of the phytoplankton biochemical composition as a biomarker of the ecosystem of different sites in River Nile.

7. Acknowledgement
This research was supported by Dr. Mohamed Gopher Head of Chemistry Lab., National Institute of Oceanography & Fisheries.

8. References

1. Abd El-Hady HH, Hussian AM. Regional and Seasonal variation of phytoplankton assemblages and its biochemical analysis in Ismailia Canal, River Nile Egypt, Journal of Applied Sciences Research. 2012; 8(7):3433-3447.
2. Abd El-Karim MS. Phytoplankton dynamic and its productivity in Damietta Branch. M.SC. Thesis, Fac. of Girls, Ain Shams University, 1999, 202.
3. Abd El-Karim MS, Abd El-Hady HH. Abundance, structure and biochemical composition of epiphytic microalgae of Cymodocea nodosa and Ruppia cirrhosa in hyper saline Mediterranean Lagoon, Bardawil Lagoon, Egypt African, J Biol Sci. 2008; 4(1):53-66.
4. Abeer MA. Separation and purification of phycocyanin from Spirulina platensis using different drying methods under indoor and outdoor condition Abbassa Int, J Aqua. 2014; 1:144-155.
5. Aspinall GO. The Polysaccharides. Academic Press, New York, 1983, 2.
6. Banerjee K, Ghosh R, Homechaudhuri S, Mitra A. Seasonal variation in the biochemical composition of red seaweed (Catenella repens) from Gangetic delta, northeast coast of India, Journal of Earth system Science. 2009; 118(5):497-505.
7. Becker EW. (Ed.) Microalgae-Biotechnology and Microbiology. Cambridge University Press, Cambridge, 1994.
8. Becker W. Microalgae in human and animal nutrition, In Richmond, A. (ed.), Handbook of micro-algal culture. Blackwell, Oxford, 2004, 312-351.
9. Biersmith A, Benner R. Carbohydrates in phytoplankton and freshly produced dissolved organic matter. Marine Chemistry 1998; (63):131-144.
10. Chabrol E, Castellano A. SPV method for estimation of total serum lipid, J Lab Clin Med. 1961; 57:300.
11. David JH, Hazel P. Analytical Biochemistry. Hand book, 1993; 18:497.
12. Dubois M, Gilles KA, Hmilton JK, Repers PA, Smith F. Colorimetric method of determination of sugars and related substances. Analyt Chem 1956; 18:350-356.
13. Field CB, Behrenfeld MJ, Randerson JT, Falkowski P. Primary production of the biosphere integrating terrestrial and oceanic components Science, 2007; (281):237-240.
14. Ganuza E, Benitez-Santana T, Atalah E. Crypthecodinium cohnil and Schizochytrium sp as potential substitutes to fisheries-derived oils from Sea Bream (Sparus aurata) Micro-diets. In Aquaculture, 2008; 277(1-2):109-116.
15. Goher ME. The environmental status of the Nile Rayahs, Egypt. Final Report, prepared to National Institute of Oceanography and Fisheries (NIOF) Egypt x (none published), 2015.
16. Gressler V, Yokoya NS, Fujii MT, Colepicolo P, Filho JM, Torres RP *et al.* Lipid, fatty acid, protein, amino acid and ash contents in four Brazilian red algae species Food Chemistry, 2009; 120(2):585-590.
17. Guil-Guerrero JL, Navarro-Juare R, Lopez-Martinez JC, Campra-Madrid P, Rebolloso-Fuentes MM. Functional properties of the biomass of three micro-algal species, Journal of Food Engineering. 2004; (65):511-517.
18. Juttner I, Heike R, Ormerod SJ. Diatoms as indicators of river quality in Nepalese Middle Hills with consideration of the effects on habitat-specific sampling. Freshwater Biology, 1996; (36):475-486.
19. Myklestad S, Haug A. Production of carbohydrate by the marine diatom Chaetoceros affinis var. Willei (Gran) Hustedt. Effect of the concentration of nutrient in the culture medium, J Exp Mar Biol Eccol. 1972; 9:125-136.
20. Oliveira MAS, Monteiro MP, Robbs PG, Ieite SG. Growth and chemical composition of Spirulina maxima and Spirulina platensis biomass at different temperatures. Aquacul Int, 1999; (7):261-275.
21. Oswald WJ. Micro-alga and wastewater treatment In M.A. Borowitzka and L.J. Borowitzka (ed.), Micro-algal biotechnology. Cambridge University press, Cambridge United Kingdom, 1992, 305-328.
22. Parsons TR, Takahashi M, Hargrave B. Biological Oceanographic Processes, 3rd ed. Pergamon Press, New York, 1984.
23. Pelizer LH, Danesi EDG, Rangel CO, Sassano GEN, Carvalho JCM, Sato S, *et al.* Influence of inoculums age and concentration in Spirulina platensis cultivation, J Food Eng. 2003; (56):371-375.
24. Renaud MS, Luong-Van JT. Seasonal variation in the chemical composition of tropical Australian marine macroalgae, Journal of Applied Phycology. 2006; 18(3-5):381-387.
25. Renaud MS, Luong-Van T, Lambrinidis G, Parry LD. Effect of temperature on the growth, chemical composition and fatty acid composition of tropical Australian microalgae grown in batch cultures. Aquacul, 2002; (211):195-214.
26. Rlos AF, Fraga F, Perez FF, Figueiras FG. Chemical composition of phytoplankton and Particulate Organic Matter in the Ria de Vigo (NW Spain). Science and Marine, 1998; 62(3):257-271.
27. Sobhy EHM. Distribution of phytoplankton and epipelic micro-algal communities of Lake Manzala, Ph.D. Thesis, Dept. of Botany, Fac. of Girls. Ain- Shams University, Egypt, 2006, 268.
28. Taha OE, Afifi MA, Sobhy EHM. Physico-chemical properties and phytoplankton composition of the River Nile at Helwan area Egypt, J Egypt Acad Soc Environ Develop (D-Environmental Studies). 2001; 2(4):1-29.
29. Talling JF, Sinada F, Taha OE, Sobhy EMH. Phytoplankton Composition, Development and Productivity. Monographiae Biologicae, 2009; 89:431-462.
30. Tanimu Y, Bako SP, Adakole JA, Tanimu J. Phytoplankton as Bioindicators of Water Quality in Saminaka Reservoir, Northern-Nigeria. International symposium on Environmental Science and Technology, Dongguan, Guangdong Province, China. Published by Science Press USA, 2011, 318-322.
31. Vonshak A, Tomaselli L. Arthrospira (Spirulina) Systematics and ecophysiology In Whitton BA, Potts M, editors. The ecology of cyanobacteriaa. The Nether Lands Kluwer Academic Publishers, 2000, 505-22.
32. Wafaa AEK, Ezzat AI, Ola EET, Abeer MA. Spirulina platensis (blue green alga) and its food value to fish fry Physiology & Algae, J Union Arab Biol. 2002; 10:57-75.