Egyptian Journal of Aquatic Biology & Fisheries
Zoology Department, Faculty of Science,
Ain Shams University, Cairo, Egypt.
ISSN 1110 – 6131
Vol. 23(4): 521 – 526 (2019)
www.ejabf.journals.ekb.eg

Assessment of phytochemical components, proximate composition and antioxidant properties of *Scenedesmus obliquus, Chlorella vulgaris* and *Spirulina platensis* algae extracts

Ghadir A. El-Chaghaby[1*], Sayed Rashad[1], Shereen F. Abdel-Kader[1], El-Shimaa A. Rawash[1] and Muhammad Abdul Moneem[2]
1- Regional Center for Food and Feed, Agricultural Research Center, Giza, Egypt
2- El-Fostat Laboratory, Cairo Water Company, Cairo, Egypt
Corresponding author : ghadiraly@yahoo.com

ARTICLE INFO
Article History:
Received: Oct. 17, 2019
Accepted: Nov. 6, 2019
Online:Nov. 11, 2019

Keywords:
antioxidant activity
phytochemical
microalgae
total phenols
proximate composition

ABSTRACT
In recent decades, natural antioxidant alternatives have become a trending topic for replacing artificial antioxidants. Microalgae have been reported to display interesting bioactive properties and their antioxidant activity is one of them. This study aims to evaluate the antioxidant capacity, phytochemical constituents and proximate composition of three microalgae *Scenedesmus obliquus*, *Chlorella vulgaris* and *Spirulina platensis*. The performed preliminary phytochemical analysis of the algae extracts revealed that they contain good amounts of bioactive compounds. The results showed that the highest total antioxidant activity found was (3720.67 mgAAE/100g) in *Spirulina platensis*, followed by *Chlorella vulgaris* (2794.80 mgAAE/100g). The lowest activity was noticed for *Scenedesmus obliquus* (1718.53 mgAAE/100g). As for total phenolic content, *Spirulina* recorded the highest phenolic content (2238.46 mgGAE/Kg.), followed by *Chlorella* (710.33mg GAE/Kg.), and then *Scenedesmus* (511.20 mgGAE/Kg). The total flavonoids content of algal extracts expressed as mgQE/Kg varied from (548.66) for *Chlorella vulgaris*, (142.23) for *Spirulina platensis* to (66.56) for *Scenedesmus obliquus*. The proximate analysis results indicated high values of protein for *Spirulina platensis* (53.30 % dry wt.) whereas the highest fat, ash and moisture percentages were recorded by *Scenedesmus obliquus* (15.13, 15.07 and 2.57, respectively).

INTRODUCTION

Due to their various phytometabolic constituents with different chemical structures and biological activities, the use of photosynthetic microorganisms, for instance, microalgae, in life sciences has been growing in recent years. These also have potential beneficial uses as valuable nourishments that can provide important physiological and pharmacological benefits for human well-being. Polyunsaturated fatty acids, sulfated polysaccharides, phycosterols, heat-induced proteins, phenolic compounds and pigments like carotenoids are the active ingredients that have a beneficial effect on human and animal health. A significant number of studies on bioactive microalgal compounds have focused on anti-inflammatory, antiviral, antimicrobial, immunological, antibacterial, medicinal and anticancer compounds (Hemalatha *et al.* 2015; Mostafa *et al.*, 2019; Rashad *et al.* 2019).

The oxidative damage caused by reactive oxygen species on lipids, proteins and nucleic acids that activate various chronic diseases, such as coronary heart disease, some synthetic antioxidants~~,~~ need to be substituted with natural antioxidants, as they have been found to be toxic and carcinogenic in animal models. It is therefore important to identify new sources of safe and cheap natural antioxidants (Hemalatha *et al.*, 2015).

Oxidative stress is the cause of multiple cellular dysfunctions. The resulting cellular damage can be found in many diseases (diabetes, cancer, atherosclerosis ...). In this respect, natural antioxidants are very advantageous. They protect the body's cells against damage caused by oxidative stress and strengthen the immune system. These natural compounds include vitamins (ascorbic acid and its derivatives, tocopherols of vegetable origin), phenolic compounds and other plant source compounds (Simioni *et al.*, 2019).

Microalgae are abundant in macromolecules and other biologically active substances including amino acids, carotenoids of polysaccharides and fatty acids. Microalgae have therefore been used extensively in food, aquaculture, pharmaceuticals and biofuels (Shao *et al.*, 2018).

Spirulina platensis attracts considerable interest among microalgae as a major source of antioxidants, carbohydrates, pigments and proteins, and as a feedstock for biofuels (Chen *et al.*, 2017; Ji *et al.*, 2017; Bauer *et al.*, 2017; Ebaid *et al.*, 2017). *Chlorella*, another microalgae, has also been reported to show antioxidant activity (Ei, 2005). *Scenedesmus sp*. is one of the first successfully grown in vitro microalgae due to its rapid growth and ability to handle. Species of the genus were used for industrial purposes worldwide because of their cultivation facilities and adaptation to environmental conditions (Simioni *et al.*, 2019).

Given the above, the present work has been carried out to evaluate the phytochemical constituents, proximate composition and antioxidant activity of three algae extracts from *Scenedesmus obliquus, Chlorella vulgaris and Spirulina platensis*.

MATERIALS AND METHODS

Preparation of algae extracts

The three algae used in the present work were *Scenedesmus obliquus, Chlorella vulgaris* and *Spirulina platensis*. These algae were produced under controlled cultivation conditions in the Algal Biotechnology Unit, at the National Research Center, in Egypt. The algae samples were purchased in dry powder form. The samples were then subjected to different chemical analysis during the study.

The algae extracts were obtained by weighing 5 grams of algae powder into 250 ml flask containing 100ml of ethanol (96%). The extraction was done by ultra-sonication for 2 hours at 25°C using an ultrasonic water bath. After extraction the samples were filtered and the solvent was evaporated using a rotary evaporator at 40°C

Phytochemical screening tests

Qualitative determination of tannins, saponins, starch, alkaloids, carbohydrates, fats and terpenoids was done following the procedures described by the methods of Harborne, (1998).

Determination of the total antioxidant capacity of algae extracts

The total antioxidant capacity of the extracts was determined by the "phosphomolybdenum" method (Prieto *et al.*, 1999). The results were calculated from a standard curve using ascorbic acid as a reference antioxidant material and results were expressed as mg ascorbic acid equivalent/100g of extract (mg AAE/100g).

Determination of the total phenolic content of algae extracts

The total phenols content of the extracts was determined using the Folin-Ciocaleau method (Turkmen *et al.*, 2006). A calibration curve of gallic acid was prepared and the results were determined from regression equation of the calibration curve and expressed as mg gallic acid equivalents per Kg of the extract (mgGAE/Kg).

Determination of the total flavonoids of algae extracts

The total flavonoids content of the extracts was determined by the aluminium chloride test (Mohdaly *et al.*, 2010) using quercetin as standard and the results were calculated as mg quercetin equivalent/Kg of extract (mgQE/Kg).

Proximate analysis

Moisture, crude protein, fat and crude fiber were determined according to the methods described by AOAC (2012).

Statistical Analysis:

All analysis tests were done in triplicates and the mean values were presented ± standard deviation.

RESULTS AND DISCUSSION

Total antioxidant activity

Microalgae are well known for the processing of pigments, fatty acids, proteins and polysaccharides (Borowitzka 2013).Due to the presence of different bioactive components with antioxidative potential in the crude extracts of the samples, total antioxidant activity of three algae is given in Table (1). The highest activities of (3720.67 ±101.69 mgAAE/100g) were observed in *Spirulina platensis,* followed by *Chlorella vulgaris* (2794.80 ±96.69 mgAAE/100g). The lowest activity was noticed from *Scenedesmus obliquus* (1718.53 ±86.64 mgAAE/100g). *Spirulina sp.* has been reported to provide some antioxidant protection both in vitro and in vivo because of the presence of α-tocopherol, β-carotene, and phenolic acids (Banskota, 2019).

Table 1: Antioxidant properties of algae extracts (mean ±SD)

	Total antioxidant capacity mgAAE/100g	Total phenolic content mgGAE/Kg	Total flavonoids mgQE/Kg
Scenedesmus obliquus	1718.53±86.64	511.20±22.14	66.56±2.29
Chlorella vulgaris	2794.80±96.69	710.33±39.97	548.66±13.34
Spirulina platensis	3720.67±101.69	2238.46 ±58.81	142.23±2.33

Total phenolics content

Microalgae contain a variety of phenolic groups but were very distinct from many other species of plants such as herbs, fruits and medicinal plants. Compared to other plants, the microalgae may contain different antioxidants (Manivannan *et al.* 2012). All tested algae extracts contained good amount of phenolic compounds varied from (2238.46±58.81 to 511.20±22.14 mg GAE/Kg) and *Spirulina* extract recorded the highest phenolic content (2238.46±58.81mgGAE/Kg.), followed by *Chlorella* sp (710.33±39.97 mg GAE/Kg.), and *Scenedesmus* sp. (511.20±22.14 mg GAE/Kg), respectively. These results are in agreement with the results of Ali and Doumandji, (2017) who reported that the microalgae are more primitive and they are capable of producing relatively complex polyphenols.

The flavonoid content

As shown in Table 1, the flavonoids content of algal extracts expressed as mgQE/Kg varied from (548.66±13.34) to (66.56±2.29). Klejdus *et al.* (2010) showed that several classes of flavonoids, such as isoflavones, flavanones, flavonols and dihydrochalcones are found in microalgae and cyanobacteria.

Proximate composition

Microalga biomass is made up of different nutritional components of which the main three are proteins, carbohydrates and lipids (Priyadarshani and Rath, 2012). The proximate nutritional compositions of three algae species are presented in Table 2. The results indicated high values of protein for *Spirulina platensis* (53.30 ± 0.22 % dry wt.) whereas the highest fat, ash and moisture percentages were recorded by *Scenedesmus obliquus* (15.13±0.12, 15.07±0.09 and 2.57±0.06 % dry wt.), respectively.

Table 2: Proximate composition of algae extracts (mean ±SD)

	Protein (%)	**Fat (%)**	**Ash (%)**	**Moisture (%)**
Scenedesmus obliquus	31.07±0.09	15.13±0.12	15.07±0.09	2.57±0.06
Chlorella vulgaris	20.67±0.05	11.90±0.08	8.87±0.05	1.05±0.04
Spirulina platensis	53.30±0.22	12.83±0.17	10.30±0.08	2.03±0.12

Phytochemical screening for three microalgae strains

Many phytochemicals such as saponins, starch and alkaloids were screened for the three microalgae. The phytochemical active secondary metabolites have been carried out for three microalgae strains, the qualitatively identified phytochemicals have been tabulated in Table 3. The results showed that the three algae extracts contained different types of phytochemicals with several bioactivities. Recently, the importance of alkaloids, saponins and tannins in different antibiotics used in the treatment of common pathogenic strains was demonstrated (Mir *et al.*, 2016).

Table 3: Phytochemical screening of the three microalgae strains

	Scenedesmus obliquus	***Chlorella vulgaris***	***Spirulina platensis***
Saponins	-	+	+
Tannins	-	-	-
Terpenoids	-	-	-
Starch	+	+	+
Fat	+	+	+
Carbohydrates	+	+	+
alkaloids	+	+	+

(+): the test result is positive, (-): the test result is negative

CONCLUSIONS

This study was conducted in order to demonstrate the presence of phytochemical constituents, proximate compositions and antioxidant activities of three algae extracts of *Scenedesmus obliquus*, *Chlorella vulgaris* and *Spirulina platensis*. The results showed that the algae species possess a good quality of phytochemicals, which directly or indirectly can help to maintain the health of living beings. Results suggest also that these microalgae have antioxidant potential that could be considered in the medication, dietary supplements, cosmetics, and food industries for future applications.

REFERENCES

Ali, I.H. and Doumandji, A. (2017). Comparative phytochemical analysis and in vitro antimicrobial activities of the cyanobacterium *Spirulina platensis* and the green alga *Chlorella pyrenoidosa* : potential application of bioactive components as an alternative to infectious diseases. Bulletin de l'Institut Scientifique, Rabat, Section Sciences de la Vie, 2017, n° 39, 41–49.

AOAC (2012). Official methods of analysis, Association of official analytical chemist 19^{th} edition, Washington D.C., USA.

Banskota, A. H. (2019). Antioxidant properties and lipid composition of selected microalgae. J. Appl Phycol., 31:309-318.

Bauer, L. M.; Costa, J.A.V.; da Rosa, A. P.C., and Santos, L. O. (2017). Growth stimulation and synthesis of lipids, pigments and antioxidants with magnetic fields in Chlorella kessleri cultivations. Bioresour. Technol., 244, 1425.

Borowitzka, M. A. (2013). High-value products from microalgae—their development and commercialisation. J. Appl. Phycol., 25:743–756.

Chen, W.; Yang, H.; Chen, Y.; Xia, M.; Yang, Z.; Wang, X. and Chen, H. (2017). Algae pyrolytic poly-generation: Influence of component difference and temperature on products characteristics. Energy, 131: 1-12.

Ebaid, R.; Elhussainy, E.; El-Shourbagy, S.; Ali, S. and Abomohra, A. (2017). Protective effect of Arthrospira platensis against liver injury induced by copper nanoparticles. Orient. Pharm. Exp. Med., 17(3): 203-210.

Ei, I. N. (2005). Antioxidant and Antiproliferative Activities of *Spirulina* and *Chlorella* Water Extracts. J. Agric. Food Chem., 4207–4212.

Harborne, J. B. (1998). Textbook of Phytochemical Methods. A Guide to Modern Techniques of Plant Analysis. 5th Edition, Chapman and Hall Ltd, London, 21-72.

Hemalatha, A.; Parthiban, C.; Saranya, C.; Girija, K. and Anantharaman, P. (2015). Evaluation of antioxidant activities and total phenolic contents of different solvent extracts of selected marine diatoms. Indian Journal of Geo-Marine Sciences, 44: 1630–1636.

Ji, C.; He, Z.; Wang, Q.; Xu, G.; Wang, S.; Xu, Z. and Ji, H., (2017). Effect of operating conditions on direct liquefaction of low-lipid microalgae in ethanol-water co-solvent for bio- oil production. Energy Convers. Manage., 141: 155–162.

Klejdus, B.; Lojková, L.; Plaza, M.; Snóblová, M. and Sterbová, D. (2010). Hyphenated technique for the extraction and determination of isoflavones in algae: Ultrasound-assisted supercritical fluid extraction followed by fast chromatography with tandem mass spectrometry. J. Chromatogr., 1217: 7956–7965.

Manivannan, K.; Anantharaman, P. and Balasubramanian, T. (2012). Evaluation of antioxidant properties of marine microalga *Chlorella marina* (Butcher, 1952). Asian Pacific Journal of Tropical Biomedicine, S342-S346.

Mir, M. A.; Parihar, K.; Tabasum, U. and Kumari, E. (2016). Estimation of alkaloid , saponin and flavonoid , content in various extracts of *Crocus sativa*. Journal of Medicinal Plants Studies, 4(5): 171-174.

Mohdaly, A., Sarhan, M., Smetanska, I. and Mahmoud, A. (2010). Antioxidant properties of various solvent extracts of potato peel, sugar beet pulp and sesame cake. J Sci Food Agr., 90: 218–26.

Mostafa, S. S.; El-Hassanin, A.S.; Rashad, S.; Soliman A. Sh. and El-Chaghaby, G. A. (2019). Microalgae growth in effluents from olive oil industry for biomass production and decreasing phenolics content of wastewater. Egyptian Journal of Aquatic Biology & Fisheries, 23(1): 359 -365.

Prieto, P.1.; Pineda, M. and Aguilar, M. (1999). Spectrophotometric quantitation of antioxidant capacity through the formation of a phosphomolybdenum complex: specific application to the determination of vitamin E. Anal Biochem., 269(2):337-341.

Priyadarshani, I. and Rath, B. (2012). Commercial and industrial applications of micro algae – A review. Journal of Algal Biomass Utilization. Phycospectrum Inc, 3(4): 89–100.

Rashad, S.; El-Hassanin, A.S.; Mostafa, S.S.M. and El-Chaghaby, G.A. (2019). Cyanobacteria cultivation using olive milling wastewater for bio-fertilization of celery plant. Glob. J. Environ. Sci. Manag., 5: 167–174.

Shao, W.; Ebaid, R.; Abomohra, A.E. and Shahen, M. (2018). Enhancement of Spirulina biomass production and cadmium biosorption using combined static magnetic field. Bioresour. Technol., 265: 163-169.

Simioni, T.; Quadri, M.B. and Derner, R.B. (2019). Drying of *Scenedesmus obliquus*: Experimental and modeling study. Algal Res., 39: 101428.

Turkmen, N.; Sari, F. and Velioglu, Y.S. (2006). Effect of extraction solvents on concentration and antioxidant activity of black and black mate polyphenols determined by ferrous tartrate and Folin-Ciocalteu methods. Food Chem., 99: 838-841.