Egyptian Journal of Aquatic Biology & Fisheries
Zoology Department, Faculty of Science,
Ain Shams University, Cairo, Egypt.
ISSN 1110 – 6131
Vol. 22(5): 419- 429 (2018)
www.ejabf.journals.ekb.eg

Nutritional value and health quotient of algae collected from Egyptian coast, Alexandria

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ARTICLE INFO
Article History:
Received: Sept. 22, 2018
Accepted: Nov. 29, 2018
Online: Dec. 30, 2018

Keywords:
Seawater
Algae
Essential minerals
Essential Trace elements
Proximate content
Nutrition

ABSTRACT
Algal species have considerable benefits to human, because of their great nutritional value. Thus, we investigated the nutrient content (essential minerals and trace elements) and the biochemical composition (proximate content) of macroalgae (green, brown and red algae). The results indicated the existance of high concentrations of the essential minerals as Na, K, Ca and Mg. Brown algae gave high Na and K values followed by red and green algae. While, Ca and Mg were distributed in high concentrations in red algae followed by brown and green algae. On the other hand, the essential trace elements (Fe, Cu, Zn and Mn) followed as Fe > Mn > Zn > Cu. Proximate content of algae (carbohydrates and proteins) in the three types of algae recorded as follow, for carbohydrates red algae > green algae > brown algae. Meanwhile, proteins concentration followed as red algae > brown algae > green algae. Finally, ion quotients are between 0.208 and 2.019 for green algae species, between 0 .722 and 2.087 for brown algae and between 0.458 and 2.433 for red algae. The nutrient content of studied stations water was investigated as well. From the concentration values of essential minerals in studied stations water, it was found that, Agamy station has the smallest values of Na (10.560 g/l), K (0.463 g/l), Ca (0.473 g/l) and Mg (1.573 g/l). The essential trace elements in stations water followed as Fe > Cu > Zn > Mn. The highest values of Fe (565.500 μg/l), Zn (20.756 μg/l) and Mn (4.803 μg/l) were recorded at Abu Quir station while, Cu measured the highest value (28.260 μg/l) at Agamy station.

INTRODUCTION

Algae using are progressively increased because of their functional benefits in addition to their traditional importance for health and nutrition. Beside their role as basic nutrition, algae are consumed as nutraceuticals, that may avail for health (e.g., disease prevention and anti-inflammatories) (Bagchi, 2006; Hafting *et al*., 2012). The algae are utilized as food for humans and animals, production of colloids (alginates, agar, furcelaran and carrageenan), soil compost, pharmaceuticals and cosmotics beside extraction of salts (iodine and soda). In the south east Asia countries algae represent one of economic resources where they are largely harvested and used in the human nutrition (Rupérez, 2002). Furthermore, algae are very useful as bioindicator for studying the contamination of environment (Cost, 1987; Cost, 1989; Caliceti *et al*., 2002). The algae composition varies according to species, year season, water temperature and geographic area (Jensen, 1993).

The algae minerals are helpful in developing the metabolic reactions. The inorganic elements or minerals are present in all tissues of body and necessary to preserve some physico-chemical processes which are necessary for life. Every shape of living matter needs these inorganic elements for its ordinary vital activities (Hays and Swenson, 1985; Ozcan, 2003). Minerals are categorized into three categories, macro (major), micro (trace) and ultra trace elements. The macro-elements comprise phosphorus, chloride, calcium and sodium, while the micro-minerals comprise copper, zinc, iron, magnesium, potassium, cobalt, iodine, manganese, molybdenum, chromium, fluoride, sulfur and selenium (Eruvbetine, 2003). Carbohydrates of algae include glucose, starch and polysaccharides which are more digestible. Therefore, it is possible to use algae in feed and dried food (Becker, 2004).

The target of this work is to assess the nutrition value of some algal species collected along Alexandria coast, Egypt.

MATERIALS AND METHODS

Study area

The sampling stations of water and marine algae at the Egyptian Mediterranean Sea coast of Alexandria region (Abu Quir, Sheraton, Stanly, El-Shatby, Eastern Harbour and Agamy) were shown in Figure1.

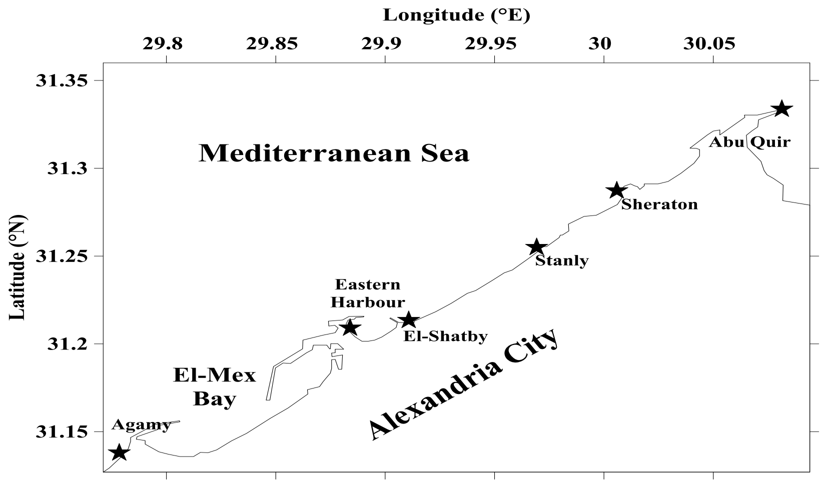

Fig. 1: Studied stations along Egyptian Mediterranean Sea coast, Alexandria.

Algae collection

Different algal species of different classes including, *Amphiroa rigida*, *Corollina officinalis*, *Pterocladiacapillacea and Jania rubens;* Division *Rhodophyceae*, *Ulva linzea* and *Ulva fasciata*; Division *Chlorophyceae* and *Colpomenia sinuosa* and *Sargassum vulgare*; Division *Phaeophyceae* were handpicked collected along Alexandria coast stations in the subtidal zone. The collected samples were nearly at the same stage of growth. Washing of picked algae in seawater at the collcting place was done. The samples were refrigerated and carried to the laboratory. On the laboratory, they were cleaned carefully under tap water. Identification of samples was carried out by species (Aleem, 1993; Riedel, 1970). Finally, small weight of each collected species was frozen and kept at 4 °C until proximate content (carbohydrates and proteins) analysis. After that all species were air dried, kept in oven overnight at 30 °C and grinded to pass a 20 mesh-screen. The grinded materials were stored in plastic bags.

Chemical analyses

Water analysis

Surface seawater were taken from coastal area of Abu-Quir to Agamy using Niskin bottles (Figure 1). At the same time of sampling, the temperature of seawater was recorded by a pocket thermometer. Salinity of seawater was measured using induction salinometer (Beckman model RS-10). The pH of seawater was recorded by a digital Jenway 3505 pH meter. Total alkalinity (TA) of collected samples was directly analyzed using volumetric titration against standard 0.01 N hydrochloric acid in presence of methyl orange (APHA,1999). Oxidizable organic matter (OOM) was analyzed using the method reported by FAO (1976). Dissolved oxygen (DO) was dtermined using Winkler's method with standard iodimetric titration (Strickland and Parsons, 1972). Ammonium ion concentrations were determined spectrophotometrically using the indophenol blue technique (IOC, 1983). Chlorophyll-a (Chl-a) was measured spectrophotometrically using the method described by Strickland and Parsons (1972).

Essential minerals (Na, K, Ca and Mg) and essential trace elements (Fe, Cu, Zn and Mn) analysis

For the studied essential minerals and essential trace elements, dried algae (0.1 g) was subjected to digestion in a solution containing the following concentrated acids; HNO_3, HF and $HClO_4$ (3:2:1) for 3h. The volume of the digested samples were reduced by heating. After that deionized distilled water was added to dilute each sample to final volum of 25 ml using a poly tetrafluoroethylene flask. Finally the prepared solutions were filtrated and kept in PVC bottles. The investigated elements in studied stations water were determined after pre-concentration from seawater by using chelex-100 cation-exchange resins according to Riley and Taylor (1968). After these procedures, the concentrations of the essential trace elements **(**Fe, Cu, Zn and Mn) in algae and seawater samples were determined utilizing atomic absorption spectrophotometer (AAS)/flame mode (Shimadzu AA-6800) (Fe, λ = 372.0 nm; Cu, λ = 324.8 nm; Zn, λ = 213.9 nm and Mn, λ = 403.1 nm) (MAA, 1998). Measurements were carried out in triplicate.

The essential minerals, Na and K were measured directly in digested algae and pre-concentrated seawater samples using Flame Photometer JENWAY Model PFP7 with a limit detection of < 0.2 ppm for both elements. Calcium was determined by the conventional titrimetric method using EDTA (Ethylene diamine tetra acetic acid disodium salt) according to APHA (1999), in which the digested algae and pre-concentrated seawater samples containing both Ca and Mg were adjusted to pH (12-13) with buffer solution and titrated with EDTA using Murexide as an indicator. Total hardness (Ca and Mg) in digested and pre-concentrated samples was determined by titration versus EDTA in presence of eriochrome black-T indicator and buffer solution to give pH (10). Magnesium was calculated from the difference between total hardness and Ca concentration values (APHA, 1999).

Proximate content (carbohydrates and proteins) of algae

Total carbohydrates analysis

At the begining, the studied algae were extracted with 2.5 N HCl. After that total carbohydrates content in the different species of algae was determined by phenol/sulfuric acid method (DuBois *et al*., 1956). UV/Visible single beam spectronic 21 D Milton Roy spectrophotometer was used. Glucose standard curve was utilized for calculating the results (Schüep and Schierle, 1995).

Proteins analysis

Proteins content was assayed using UV/Visible single beam spectronic 21 D Milton Roy spectrophotometer. Pierce test kit (BCA 23225) was utilized according to the methods of Lowry *et al*. (1954) and Kreeger *et al*. (1997). Standardization was done with bovine serum albumin and measurements were taken at 562 nm.

RESULTS

The tested algae contained high quantity of the essential minerals (Na, K, Ca and Mg). Green algae gave the following ranges of Na (0.678-1.340 mg/g), K (0.121-0.547 mg/g), Ca (3.835-57.271 mg/g) and Mg (9.306-51.987 mg/g). Meanwhile, brown algae recorded different ranges of Na (0.960-1.508 mg/g), K (0.156-0.906 mg/g), Ca (9.824-93.922 mg/g) and Mg (14.897-44.978 mg/g). Red algae showed various contents of Na (0.763-1.767 mg/g), K (0.072-0.773 mg/g), Ca (14.706-352.266 mg/g) and Mg (12.901-89.514 mg/g). Concentration of Na followed as red algae > brown algae > green algae; K followed as brown algae > red algae > green algae; Ca followed as red algae > brown algae > green algae and Mg followed as red algae > green algae > brown algae (Table 1).

Table 1: Essential minerals and essential trace elements in different species of algae collected from Alexandria, Egyptian Mediterranean Sea coast.

Algae species	Na (mg/g)	K (mg/g)	Ca (mg/g)	Mg (mg/g)	Fe (µg/g)	Cu (µg/g)	Zn (µg/g)	Mn (µg/g)
Green algae								
Ulva linza, Abu Quir	1.339	0.320	57.271	28.698	314.737	2.982	42.122	28.790
Ulva fasciata, Abu Quir	1.012	0.547	29.399	38.638	501.834	4.279	22.738	31.589
Ulva fasciata, Sheraton	1.340	0.533	17.141	51.987	283.847	1.222	18.206	35.802
Ulva fasciata, Stanlly	1.164	0.415	3.835	9.306	126.871	1.871	19.461	29.990
Ulva fasciata, El-Shatby	1.099	0.522	9.980	42.376	389.442	7.719	13.073	37.849
Ulva fasciata, E. Harbour	0.998	0.540	4.963	27.094	102.526	4.210	58.321	19.936
Ulva fasciata, Agamy	0.678	0.121	12.352	10.490	146.450	4.931	39.448	23.817
mean	**1.090**	**0.428**	**19.277**	**29.791**	**266.529**	**3.887**	**30.481**	**29.681**
brown algae								
Sargassum vulgare, Abu Quir	0.960	0.769	93.922	0.960	2119.388	22.077	30.340	66.169
Colpomenia sinuosa, Abu Quir	1.508	0.906	69.583	1.508	1360.863	10.045	29.638	53.770
Colpomenia sinuosa, Agamy	1.042	0.156	9.824	1.042	805.761	0.615	42.959	48.535
mean	**1.170**	**0.610**	**57.770**	**1.170**	**1428.670**	**10.912**	**34.312**	**56.158**
Red algae								
Amphiroa rigida, Abu Quir	1.376	0.136	352.266	1.376	851.196	16.724	28.687	102.222
Corallina officinalis, Abu Quir	1.117	0.186	30.722	1.117	272.964	0.621	37.115	44.079
Pterocladia capillacea, Abu Quir	0.763	0.773	37.020	0.763	1412.438	10.837	62.315	54.470
Pterocladia capillacea, Agamy	0.819	0.072	14.706	0.819	269.325	1.223	22.872	19.606
Jania rubens, Abu Quir	1.767	0.319	39.352	1.767	539.764	6.259	25.773	125.908
mean	**1.168**	**0.297**	**94.813**	**1.168**	**561.184**	**7.132**	**35.352**	**69.257**

On the other hand amongst essential trace elements (Fe, Cu, Zn and Mn) the iron contents were found to be the highest while, Cu contents were the lowest. Fe measured the highest mean value, 1428.670 µg/g in brown algae and Cu measured the lowest mean value, 3.887 µg/g in green algea. In green algae the highest value of Fe, 501.834 µg/g and the lowest value of Cu, 1.222 µg/g. In brown algae Fe measured the highest value 2119.388 µg/g and Cu measured the lowest value 0.615 µg/g. In red algae Fe recorded 1412.438 as the highest value and Cu measured the lowest value of 0.621 µg/g. Most of seaweeds showed high level of Zn metal, where the mean values varied from 30.481 µg/g in green algae to 34.312 in brown algae and 35.352 in red algae. Where, Zn content followed as red algae > brown algae > green algae. The results indicated that the highest values of Zn (62.315 and 58.321 µg/g) were recorded in red and green algae, respectively while, the lowest one was found in green algae (13.073 µg/g). High levels of Mn metal were found in studied algea. The mean values varied from 29.681 µg/g in green algae to 56.158 in brown algae and 69.257 in red algae. Where, Mn content followed as red algae > brown algae > green algae. The highest values of Mn (125.908 and 102.222 µg/g) were recorded in red algae while, the lowest ones (19.606 and 19.936 µg/g) were found in red and green algae, respectively (Table 1).

Table 2 represented concentrations of essential minerals (Na, K, Ca and Mg) and essential trace elements (Fe, Cu, Zn and Mn) in studied stations water. Mean values of essential minerals concentration recorded, Na 11.353 g/l, K 0.519 g/l, Ca 0.513 g/l and Mg 1.895 g/l. It was observed that Agamy station has the smallest values of Na (10.560 g/l), K (0.463 g/l), Ca (0.473 g/l) and Mg (1.573 g/l). The mean values of essential trace elements concentrations in stations water recorded, Fe (342.587 µg/l), Cu (9.760 µg/l), Zn (5.767 µg/l) and Mn (1.979 µg/l). They followed as Fe > Cu > Zn > Mn. The highest values of Fe (565.505 µg/l), Zn (20.756 µg/l) and Mn (4.803 µg/l) were recorded at Abu Quir station while, Cu measured the highest values 28.260, 10.242 and 8.425 µg/l at Agamy, El-Shatby and Eastern Harbour, respectively.

Table 2: Essential minerals and essential trace elements in seawater.

Stations	Na (g/l)	K (g/l)	Ca (g/l)	Mg (g/l)	Fe (µg/l)	Cu (µg/l)	Zn (µg/l)	Mn (µg/l)
Abu Quir	11.490	0.536	0.505	1.955	565.505	3.836	20.756	4.803
Sheraton	11.820	0.526	0.497	1.935	335.341	3.907	6.250	1.184
Stanlly	11.330	0.534	0.537	1.997	164.540	3.893	1.929	0.926
El-Shatby	11.600	0.537	0.537	1.997	451.257	10.242	2.767	2.068
E. Harbour	11.320	0.521	0.529	1.916	98.482	8.425	0.899	0.605
Agamy	10.560	0.463	0.473	1.573	440.400	28.260	2.003	2.291
mean	**11.353**	**0.519**	**0.513**	**1.895**	**342.587**	**9.760**	**5.767**	**1.979**

Physical and chemical parameters of studied stations water were given in Table 3. Water temperature ranged between 22.0 °C at Sheraton station and 26.5 °C at Eastern Harbour. Salinity values varied with a maximum value (37.45 ‰) at Stanly and a lowest value (34.33 ‰) at Agamy. The highest pH value (8.48) was recorded at El-Shatby and the lowest value (8.03) was observed at Eastern Harbour. Total alkalinity (TA) values ranged between 2.60 meq/l at Abu Quir and 3.00 meq/l at Agamy.

Table 3: Physical and chemical parameters of seawater.

Stations	Temperature, T (°C)	Salinity, (‰)	pH	Total Alkalinity, TA (meq/l)	OOM, (mg O_2/l)	DO, (ml O_2/l)	ammonium, (µM/l)	Chlorophyl a, Chl-a (µg/l)
Abu Quir	25.0	35.84	8.15	2.60	1.216	7.874	3.45	0.552
Sheraton	22.0	37.17	8.09	2.80	1.824	7.022	26.40	0.612
Stanly	26.0	37.45	8.09	2.75	3.344	6.597	12.65	1.895
El-Shatby	22.5	35.62	8.48	2.95	6.688	7.661	3.05	6.999
E. Harbour	26.5	36.82	8.03	2.70	2.432	3.405	4.50	1.392
Agamy	25.0	34.33	8.14	3.00	0.912	6.703	11.85	0.301

The levels of OOM ranged between 0.912 mg O_2/l at Agamy and 6.688 mg O_2/l at El-Shatby. The minimum value of DO (3.405 ml O_2/l) was recorded at Eastern Harbour while the maximum one (7.874 ml O_2/l) was recorded at Abu Quir. The maximum value of ammonium (26.40 µM/l) appeared at Sheraton station and the minimum one (3.05 µM/l) appeared at El-Shatby. The levels of Chl-a in the studied water varied from 0.301 µg/l at Agamy to 6.999 µg/l at El-Shatby.

Proximate content (carbohydrates and proteins) of algae

Proximate content in the three types of algae recorded as follow, for carbohydrates red algae > green algae > brown algae (136.127, 114.167 and 67.320 mg/g). Meanwhile, proteins concentration followed as red algae > brown algae > green algae (1.164, 0.946 and 0.882 g%) (Table 4).

Table 4: Proximate content (carbohydrates, mg/g and proteins, g%) of different species of algae.

Algae species	**Total Carbohydrates,** (mg/g)	**Total proteins,** (g%)
Green algae		
Ulva linza, Abu Quir	82.010	1.431
Ulva fasciata, Abu Quir	134.790	1.010
Ulva fasciata, Sheraton	94.420	1.200
Ulva fasciata, Stanlly	124.420	1.154
Ulva fasciata, El-Shatby	146.730	0.185
Ulva fasciata, E. Harbour	91.430	0.461
Ulva fasciata, Agamy	125.370	0.739
mean	**114.167**	**0.882**
brown algae		
Sargassum vulgare, Abu Quir	57.500	0.092
Colpomenia sinuosa, Abu Quir	77.140	1.800
mean	**67.320**	**0.946**
Red algae		
Amphiroa rigida, Abu Quir	34.720	1.476
Corallina officinalis, Abu Quir	124.740	2.030
Pterocladia capillacea, Abu Quir	264.710	0.738
Jania rubens, Abu Quir	120.340	0.415
mean	**136.127**	**1.164**

Ion quotient

To identify minerals in water, magnesium and calcium contents (hardness) and the ratio of them are usually determined. The ion quotient can be studied not only for water but also for plants, animals and humans. It is calculated from the following equation and the concentrations are expresed in moles (Csikkel-Szolnoki *et al*., 2000; Kiss *et al*., 2004).

Ion quotient = $[Ca^{2+} + Na^{2+}] / [Mg^{2+} + K^{2+}]$

From Table 5 the ion quotients were in the range of 0.208- 2.019 for green algae and 0.722-2.087 for brown algae. Meanwhile, for red algae they were in the range of 0.458-2.433.

Table 5: Ion quotients in the different algae species.

Stations	**Algae species**	***IQ***
	Green Algae	
Abu Quir	*Ulva Linza*	2.019
Abu Quir	*Ulva Fasciata*	0.776
Sheraton	*Ulva Fasciata*	0.352
Stanly	*Ulva Fasciata*	0.514
El-Shatby	*Ulva fasciata*	0.256
E. Harbour	*Ulva fasciata*	0.208
Agamy	*Ulva fasciata*	1.228
	Brown Algae	
Abu quir	*Sargassum Vulgare*	2.074
Abu quir	*Colpomenia Sinuosa*	2.087
Agamy	*Colpomenia Sinuosa*	0.722
	Red Algae	
Abu Quir	*Amphiroa Rigida*	0.513
Abu Quir	*Corallina Officinalis*	2.433
Abu Quir	*Peterocladia Capillacea*	1.627
Abu Quir	*Jania Rubens*	0.458
Agamy	*Peterocladia Capillaceous*	1.039

DISCUSSION

Mineral nutrients are inorganic elements wanted in littel quantities ranging from less than 1 to 2500 mg per day, basing on the type of minerals. They are essential for maintaining certain physico-chemical processes necessary for life (Eruvbetine, 2003).

Essential minerals

It is difficult to compare calcium content in algae collected from different countries due to dependence of calcium concentration on physical parameters of water where, calcium concentrations are high in alkaline medium and low in acidic medium (Brody, 1994). Red algae recorded higher calcium content than that in brown and green algae (Table 1). Calcium is important because of its role in bone, teeth, muscles and heart functions. Meanwhile, values of sodium and potassium differed in algae collected from various places and in different types of algae (Table 1). Increasing the concentration of potassium in the blood leads to decreased kidney function, unusual destroy of protein, inflammation of infection and damage of the intestine. Na has an essential participation in the metabolites transportation. The K/Na ratio in meals is a very important factor in forbidding of hypertension and arteriosclerosis (Saupi*et al*., 2009).

Concentration of Mg presented in high value in red algae followed by brown algae (Table 1). In humans, Mg is wanted in plasma and extracellular fluid, as it assists maintaining an osmotic balance. It is demanded in various catalyst enzyme interactions, particularly those involving nucleotides where the active species are magnesium salts. Decrease of Mg is correlated with uncommon irritability of muscles and convulsions while, increase of Mg is associated with depression in the central nervous system (Bhowmik*etal*., 2012). Magnesium are good for building of red blood cells, fixing of worn out cells and preserving body mechanisms (WHO, 1996). Lack of magnesium and calcium in food may cause weak, bad bone expansion and stunted growth (Effiong and Udo, 2010). From the data of ion quotient, the molar concentration revealed that feeding on all species of algae can reduce hypertension, preeclampsia and heart disease (Table 5).

Essential trace elements

The highest concentration of iron was found in brown algae and then in red algae, the lowest one was found in green algae (Table 1). Iron plays an important role in human health. Iron is a main component of hemoglobin formation, normal functioning of the central nervous system and oxidation of proteins, carbohydrates and fats (Odhav *et al*., 2007). On the other hand, the value of Cu in the investigated samples varied between the highest value in brown algae followed by red algae meanwhile, the lowest value recorded in green algae (Table 1). The differences in content of metals in the studied algae depend on the physico-chemical nature of the sediments and the metal absorption capacity of each algae, which affected by different factors such as environmental and human interference. Copper is an important essential element to living organisms. It acts as a component of many bio-oxidation enzymes. It exists in plasma protein of blood as erythrocuprin. Copper is the essential micronutrient needed for the hematological and neural system (Tan *et al*., 2006).

The content of zinc existed in relatively similar amounts in the studied algal species. Maximum concentration recorded in red algae and the lowest one found in green algae (Table 1). Zinc is a very important mineral for natural growth in humans. Referring to FAO's food budget reports, nearly 20% of the people around the world are considered to be at danger of zinc insufficiency (Allen *et al*., 2006). It could be because of food deficiency, poor absorption, too much secretion, or inherited defects in zinc metabolism. Zn is considered as a basic metal for the work of different enzymes. Lack of Zn in children, may cause loss of appetite, delayed growth and stagnation of sexual growth (Saracoglu *et al*., 2009). Manganese content in the studied macroalgae followed as red algae > brown algae > green algae (Table 1). Manganese activates the formation of amino acids, activates certain enzymes and activates co enzyme. It acts as a cofactor of the enzyme which is a mitochondrial superoxide dismutase. Manganese is portion of the enzymes participating in the formation of urea. Manganese is concentrated in the mitochondria, where it participates in oxidative phosphorylation partial regulation. Manganese absorption is prevented by excessive amounts of phosphate and calcium in food (Tan *et al*., 2006).

Proximate content

Carbohydrates are the primary energy reserves in adults. Polysaccharides extracted from algae showed good immune effects in vitro and also in vivo (Pasco and Pugh, 2010; Suárez *et al*., 2010; Watanabe and Seto, 1989). From this study, approximately the concentration of carbohydrates in green and red algae were the same. Proteins are the basic units for the production of vital tissues and enzymes in all animals. Therefore, the dietary protein must be sufficient for tissue production and metabolic processes. The rapidly growing cells are characterized by high protein and low carbohydrate content (CHO). When cells reach a fixed stage, more carbon is incorporated into CHO and/or fat (Zhu *et al*., 1997; El-Said and El-Sikaily, 2013). Proteins percentage varied to a large degree in the studied algae species. Amongst the investigated algae, red and green species possessed high percentages of proteins (dry weight %) while, lower percentages were found in brown algae species. Carbohydrates and Proteins that run away from digestion in the small intestine are very important for humans. They indirectly stimulate the immune response by raising microbial reactions (Cian et al., 2015). The dietary modification of colonic flora plants and the effect of bacterial fermentation products on human health are under investigation (Angell *et al*., 2016; Dawczynski*et al*., 2007; Holdt and Kraan, 2011; Pereira, 2011; Taboada *et al*., 2013). Duffy *et al*., 2015 found that, the mean concentration of proteins in brown and green algae were the same. This finding was not in agreement with the results of this study.

CONCLUSION

Algae consumption is increasing for functional benefits beyond traditional nutrition and health considerations. The most important nutrients for disease resistance are Na, K, Ca, Mg, Fe, Cu, Zn and Mn. Therefore, this research sought to study the basic minerals and trace elements in green, brown and red algae as well as to study the chemical composition of these algae (carbohydrates and proteins). According to the presented results, the investigated species of algae can be considered as a good source of polysaccharides. Among marine algae, red and green algae often contain high levels of proteins while, low values are recorded in brown algae. The mineral content differences in studied species based on the physico-chemical properties of the sediments and the ability of metal to be absorbed by algae from the ecosystem, which are modified by different factors such as environmental and human interference. Besides the fact that algae act as a source of nutrients, red algae recorded a high percentage of calcium, including in brown and green algae. Owing to the computed ion quotient data, all presented algal species can help in decreasing symptoms of some diseases including, hypertension, preeclampsia and cardiac disease.

ACKNOWLEDGMENT

The authors are thankful to Dr. Mona M. Ismail (Taxonomy and biodiversity of aquatic biota Lab., National Institute of Oceanography and Fisheries, Alexandria branch) for her efforts in systematic identification of the collected seaweed spp.

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ARABIC SUMMARY

القيمه الغذائيه و الصحيه للطحالب التي تم جمعها من الساحل المصري، الاسكندريه

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الطحالب البحرية لها اهميه كبيره وذلك بسبب القيمه الغذائيه والصحيه العاليه التي يمكن ان تمد الانسان بها. وبناء عليه فالهدف من هذه الدراسة هو تقدير القيمه الغذائيه للطحالب البحرية وذلك عن طريق تقدير المحتوي الغذائي (المعادن الاساسيه والعناصر الشحيحه الاساسيه) والتركيب الكيميائي الحيوي (المحتوي التقريبي) لبعض الانواع من الطحالب الخضراء والبنيه والحمراء المجمعه عبر شاطئ مدينة الاسكندريه، مصر. وقد اوضحت النتائج ان الطحالب موضع الدراسه تحتوي علي كميات كبيره من المعادن الاساسيه مثل Na، K، Ca وMg. كما لوحظ ان اعلي قيمه من NaوK توجد في الطحالب البنيه يليها الطحالب الحمراء والخضراء. بينما وجد Ca وMg بتركيزات كبيره في الطحالب الحمراء يليها الطحالب البنيه والخضراء. ومن ناحة اخري وجد ان متوسط تركيزات العناصر الشحيحه الاساسيه وهي Fe، Cu، Zn وMn في الطحالب المدروسه تتبع الترتيب التالي $Cu < Zn < Mn < Fe$.

بالنسبه للمحتوي التقريبي (الكربوهيدرات والبروتينات) في الثلاثة انواع المدروسه من الطحالب وجد ان متوسط تركيزات الكربوهيدرات تتبع الترتيب التالي، الطحالب الحمراء $>$ الطحالب الخضراء $>$ الطحالب البنيه. بينما متوسط تركيزات البروتينات تتبع الترتيب، الطحالب الحمراء $>$ الطحالب البنيه $>$ الطحالب الخضراء. وبحساب حواصل الايون وجد انها تتراوح بين 0.208 ، 2.019 للطحالب الخضراء وبين 0.722 ، 2.087 للطحالب البنيه وبين 0.458 ، 2.433 للطحالب الحمراء. نتيجة لبيانات حاصل الايون المحسوب، جميع انواع الطحالب المعروضه تستطيع المساعده في تقليل اعراض بعض الامراض بما في ذلك ارتفاع ضغط الدم، تسمم الحمل وامراض القلب.

بالاضافه لذلك فقد قيم المحتوي الغذائي لمياه المحطات الخاضعه للدراسه. وقد وجد ان مياه محطة العجمي تحتوي علي اقل قيم لتركيز كل من Na (10.560 g/l)، K (0.463 g/l)، Ca (0.473 g/l) وMg (1.573 g/l). ومن ناحية اخري فقد وجد ان العناصر الشحيحه الاساسيه في مياه المحطات المدروسه تتبع الترتيب التالي $Mn < Zn < Cu < Fe$. وقد سجلت مياه محطة ابوقير اعلي تركيزات لكل من Fe (565.500 µg/l)، Zn (20.756 µg/l) وMn (4.803 µg/l) بينما اعلي قيمة لل Cu (28.260 µg/l) وجدت في مياه محطة العجمي.