Brown algae (Sargassum subrepandum) located on the Egyptian seashores is a valuable source of nutrients and bioactive compounds with important biological/therapeutic roles

by

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Abstract:

The food gap/crisis coincided with the exacerbation of chemically synthetic drugs in most countries of the world. Therefore, the world's attention is directed to the search for untraditional foods and biologically active compounds from natural sources. The present study aims to investigate the Brown algae (Sargassum subrepandum) located on the Egyptian seashores as a valuable source of nutrients and bioactive compounds with important biological/therapeutic roles. Results indicated that carbohydrates were the largest compound (55.83 – 62.19%) followed by crude fiber (11.76 - 15.69%), ash (9.33 - 13.06%), total protein (4.74 - 5.95%) and crude fat (0.51 -1.07%) in Sargassum subrepandum powder (SSP). Also, polysaccharides were the largest compound ranged 132.45 to 173.7 mg starch equvalent. g-1 followed by phenolics (103.66 to 158.98 mg gallic acid equvalent. g-1),

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carotenoids (27.84 to 49.17 mg.g-1), flavonoids (27.11 to 37.98 mg catechin equivalent. g-1) and anthocyanin's (5.91 to 8.03 mg Cyanidin 3-glucoside, CCy3G equivalent.100g-1) in the same samples. This high content of biologically active constituents in SSP has encountered by many significance biological roles such as antioxidant and free radical scavenging activities. The degree of biological activity was also affected by the difference in the extraction medium, where the organic extracts (methanolic and ethanolic) recorded the highest values of activities, followed by the aqueous ones. The activities degree of organic extracts is coming well i.e. closing to the value of 50 mg α-tocopherol followed by the aquatic extracts. In conclusion, SSP contains different nutrients with high nutritive values and bioactive constituents that are responsible for different biological activities including antioxidant and radical scavenging activities. Therefore, we recommended SPP to be included in our daily diets/dishes, drinks, food supplementation and pharmacological formulae.

Keywords: Sargassum subrepandum powder, chemical composition, nutritional evaluation, antioxidant, scavenging activity.

Introduction

Food gap means the disproportion between the required food quantities and the number of the population, which may lead the concerned country to import food from abroad (Al-Ajili, 2012). Thus, any shortage of food resources is offset by an increase in the population. There are many factors that contribute to widening the food gap, for example, limited investment in agricultural and food projects (El-Sherbiny, 2012). Several studies also indicated that the food gap in the Arab world had reached US$128 billion in 2015, and in 2013 the Secretary-General for Economic Affairs of the General Secretariat of the Council of Arab States announced that it would take 30 years for Arab countries to bridge the food gap (Al-Hammadi, 2013). On the other hand, the food gap/crisis coincided with the exacerbation of chemically manufactured treatments and drugs. Therefore, the world's attention is directed to the search for untraditional foods and biologically active compounds from natural sources. On the top of these sources are marine plant organisms such as brown algae, due to their rapid growth and reproduction in various climatic conditions, their lack of need for special care treatments, and their richness in nutrients and various groups of bioactive constituents. All of these factors and more make the brown algae an affordable and accessible source of nutrients, as well as a promising source of nutraceuticals.

Brown algae belong to Family, Phaeophyceae are a large group of mostly marine multicellular algae, including many seaweeds located in different countries around the world including Egypt. They are a diverse group of aquatic organisms, which are described as having the ability to perform photosynthesis. Some types of Brown algae are also familiar to most people as food and as habitats. Despite this, there is a vast and diverse world of algae including Brown algae that not only help us with life, but are essential to our existence in it (Guiry, 2001). Brown algae are members of the Heterokontophyta category of eukaryotic creatures, which are identified by their chloroplasts being surrounded by four membranes, implying that they evolved through a symbiotic interaction between a basic eukaryote and another eukaryotic cell. Most Brown algae contains the pigment fucoxanthin, which gives them their name and gives them their unique greenish-brown hue (Mann and Martin, 2002). In the littoral zone of the Egyptian coast, Brown algae is currently the most dominant group. Sargassum subrepandum, a members of Sargassum genus represent valuable source of a several nutritional and nutraceuticals compounds. Our previous studies indicated that Sargassum subrepandum powder (SSP) contains proteins, lipids, minerals, fiber, carbohydrates and bioactive compounds including polysaccharides, phenolics, dietary fiber, anthocyanins, carotenoids, tannins and flavonoids (El-Gamal, 2020, Elhassaneen et al., 2021). Other components include free mannitol, minerals such as iodine and arsenic (inorganic and organic), peptides, fatty compounds, free fatty and amino acids and various pigments were also determined (Chapman and Chapman, 1980, Helen, 2003; Hossain et al., 2003; El-Gamal, 2020). From a nutritional and therapeutic point of view, Brown algae including Sargassum subrepandum are used dried in condiment and soup bases or eaten fresh in salads, rolls, or stews, or with rice. It is thought that the overall content of certain traditional Asian diets contributes to the low incidence of cancer, particularly breast cancer (Kanke et al., 1998; Funahashi et al., 2001; Lawson et al., 2001). SSP dietary intervention reduced blood pressure and cholesterol levels, suppressed the urinary markers of bone resorption, and attenuated a tendency toward diabetes (Yamori et al., 2001; Elhassaneen et al., 2020-a). On the other side, several studies have discovered the protective effect of SSP on different complications including serum lipid profile, hyperglycemia, cardiovascular disease, atherosclerosis, liver and kidney functions (El-Gamal, 2020; Elhassaneen et al., 2020-a and 2022) in obese experimental animal model.

Although all the previous studies and others dealt with many of the biological effects of BA, there is still a need to conduct more and more research to explore other roles that this important food source can play. Therefore, the present study aims to determine the chemical composition, nutritional value and bioactive compounds in Sargassum subrepandum collected from the Egyptian seashores. Also, the different biological activities of such algae will be in the scope of this investigation.

Materials and Methods

Materials

Sargassum subrepandum samples

Sargassum subrepandum were collected from the coasts of Mediterranean Sea, Alexandria, Alexandria Governorate, Egypt. The algae samples were verified by the staff in Faculty of Agriculture, Alexandria University, Alexandria, Egypt.

Chemicals, solvents and buffers

All bioactive compounds standard (gallic acid, catechin, β-carotene, Cyanidin 3-glucoside and starch) and DDPH (2,2-diphenyl-1-picrylhydrazyl) were purchased from Egyptian agent of Sigma Chemical Co. (St. Louis, MO). All other chemicals (Except as otherwise stated) including, reagents and solvents were of analytical grade were purchased from El-Ghomhorya Company for Trading Drug, Chemicals and Medical Instruments, Cairo, Egypt.

Methods

Preparation of Sargassum subrepandum powder (SSP)

Sargassum subrepandum collecting samples were cleaning and sorting manually and then dried in a hot air oven (Horizontal Forced Air Drier, Proctor and Schwartz Inc., Philadelphia, PA) at 55 0C until arriving by the moisture in the final product to about 10%. The dried samples were ground into a fine powder in high mixer speed (Moulinex Egypt, ElAraby Co., Benha, Egypt). The material that passed through an 80 mesh sieve was retained for Feeding/intervention rats protocol.

Preparation of SSP extracts

SSP was used for their different types extracts as follow: A 20 g from dried SSP plus 180 ml water were homogenized and transferred to a beaker and stirred at 200 rpm in an orbital shaker (Unimax 1010, Heidolph Instruments GmbH & Co. KG, Germany) for 1 h at room temperature. The extract was then separated from the residue by filtration through Whatman No. 1 filter paper. The remaining residue was re-extracted twice, and then the two extracts were combined. The residual solvent of was removed under reduced pressure at 55°C using a rotary evaporator (Laborata 4000; Heidolph Instruments GmbH & Co. KG, Germany). The same protocol was followed as before with changing the extraction medium with Metanol (80%, v/v) and Ethanol (80%, v/v) respectively. The residual solvent of was removed under reduced pressure at 45°C using a rotary evaporator. All extracts (Aqueous, Mehanolic and Ethanolic) could be ready for physical and chemical studies as well as the basil diet blending purpose (Feeding rats protocol).

Chemical analysis of SSP

BA samples were analyzed for proximate chemical composition including moisture, protein (T.N. × 6.25, micro - kjeldahl method using semiautomatic apparatus, Velp company, Italy) , fat (soxhelt miautomatic apparatus Velp company, Italy , petroleum ether solvent), ash and fiber contents were determined using the methods described in the AOAC, (1995). Carbohydrates calculated by differences: Carbohydrates (%) = 100 - (% moisture + % protein + % fat + % Ash + % fiber).

Determination of nutritional value of brown algae (Sargassum subrepandum) powder

Total energy value

Total energy (Kcal/100 g) of brown algae (Sargassum subrepandum) powder samples was calculated according to Insel et al, (2002) using the following equation: Total energy value (Kcal/100 g) = 4 (Protein % + carbohydrates %) + 9 (Fat %)

Satisfaction of the daily needs of adult man (25-50 year old) in protein

Grams consumed (G.D.R. g) of food (wet weight basis) to cover the daily requirements of adult man (63 g) in protein was calculated using the RDA (1989) values. Percent satisfaction of the daily requirement of adult man in protein (P.S., %) when consuming the possibly commonly used portions in Egypt i.e. one bag (100 g weight), was also calculated.

Satisfaction of the daily requirements of adult man (25-50 year old) in energy

Grams consumed of food (wet weight basis) to cover the daily requirements of man in energy (G.D.R. g) were calculated using the RDA (Recommended dietary allowances) which are 2900 Kcal /day for man as given by RDA (1989). The percent satisfaction (P.S., %) of the daily needs of adult man (25 -50 year old , 79 Kg weight and 176 cm height) in energy upon consumption the commonly used portion at homes in Egypt, i.e. i.e. one bag (100 g weight), was also calculated.

Biological activities

Antioxidant activity (β-carotene bleaching, BCB assay)

Antioxidant activity (AA) of plant extracts and standards (α-tocopherol and BHT) was determined according to the BCB assay following a modification of the procedure described by Marco, (1968).

DPPH radical scavenging assay

Free radical scavenging ability of brown algae (Sargassum subrepandum) extracts was tested by DPPH radical scavenging assay as described by Desmarchelier et al. (1997). Also, inhibition (%) was plotted against concentration, and IC50 was calculated from the graph.

Bioactive compounds determination

Total phenolics and carotenoids

Total phenolics in brown algae (Sargassum subrepandum) extracts were determined using Folin-Ciocalteu reagent according to Singleton and Rossi, (1965) and Wolfe et al., (2003). Gallic acid and equivalents are used to express the results (GAE). The total carotenoids in 80% acetone extract were determined by using the method reported by Litchenthaler (1987).

Total flavonoids

Total flavonoids contents in brown algae (Sargassum subrepandum) extracts were estimated using colorimetric assay described by Zhisen et al., (1999). Total flavonoid content was measured in mg of catechin equivalent (CAE) per gram of dry extract.

Total anthocyanins

Total content of anthocyanins in Sargassum subrepandum extracts was measured spectrophotometrically using molar extinction coefficient of cyanidin-3,5-diglucoside (26 300 M−1 cm−1) as described by Sharif et al., (2011).

Total polysaccharides

Total polysaccharides were determined in brown algae (Sargassum subrepandum) samples by spectroscopic analysis technique using a UV- visible-light spectrophotometer according to the method of Vazirian et al., (2014). Starch was used as a standard and the results were expressed as mg of starch equivalents per g of dw.

Results and Discussion

Chemical and nutritional study of Sargassum subrepandum powder (SSP)

Proximate chemical composition

The proximate chemical composition of SSP is shown in Table (1). Such data indicated that carbohydrates were the largest compound (55.83 – 62.19%) followed by crude fiber (11.76 - 15.69%), ash (9.33 - 13.06%), total protein (4.74 - 5.95%) and crude fat (0.51 -1.07%.). The present data are in partially accordance with that observed by many authors which mentioned that the greater portion of SSP collected from the Egyptian coasts is carbohydrates (El-Gamal, 2020; Fayez, 2021; Elhassaneen et al., 2021, Abd Elalal et al., 2021). Also, the same results were recorded by samples collected from other world area (Percival, 1979; Mabeau and Fleurence, 1993; Holdt and Kraan, 2011; Manteu et al. (2018). For moisture content in SS algae was determined as 7.21 - 13.05%. Such values were less than recorded by Nally and Junianto (2020) and Manteu et al. (2018), 21.61% and 17.69%, respectively. These fluctuating in moisture content of Sargassum genus are influenced by the drying process, the respective characteristics, and water location. The low moisture content recorded in the present study samples is useful to determine material durability and best storage condition for samples in order to prevent microbial activity in particular fungus. Although SSP are represent low-calorie foods however their carbohydrate content is generally high. In the same direction, Holdt and Kraan, (2011) reported that algae genus Sargassum contains a large amount of carbohydrate as structural, storage, and functional polysaccharides, and the total carbohydrate content may range 20% - 76% of dry weight depending on the species. On the other side, SSP carbohydrates possessing a fiber level greater than those recorded for many vegetables or fruits (Darcy-Vrillon, 1993; MacArtain et al., 2007). Hydrocolloids such as alginate, agar, carrageenans, fucoidan, and laminaran are abundant among the fibers in algae. The ash content of SSP is the third highest value after carbohydrate and crude fiber which is probably attributed to the mineral nutrient absorption, besides being a form of adaptation to environmental conditions containing various minerals in high concentrations (Diachantry et al. 2017; Vijay et al. (2017). The protein content in SSP is formed from several amino acids bound by peptides (Ratarana-arporn and Chirapart, 2006). In similar study, Burtin (2006) recorded lower protein content in brown algae (5-15%) compared to the red and green genus (10-30%). The fat content of SSP was low. Several studies have identified a range of 0.5 to 0.79% in Sargassum genus (Manteu et al., 2018 ; Gazali et al., 2018). Also, Garcia et al., (2016) reported that brown algae species in the tropics possess a much lower fat content than those in the sub-tropics. From all the above studies and others it could be concluded that the fluctuating in chemical composition of SSP are strongly influenced by season, water location, light intensity and duration, water and air temperature, water depth, nutrients in media, water pH, water salinity, residents' activities and drying process (Antonopoulou et al., 2005; Guschina and Harwood, 2006; Abd Elalal et al., 2021; Elhassaneen et al., 2021).

Table 1. Proximate composition of SSP (g/100 sample)

Component	Range	Mean ± SD
Moisture	7.21 - 13.05	9.16 ± 2.61
Total protein	4.74 - 5.95	5.12 ± 0.65
Crude fat	0.51 -1.07	0.88 ± 0.32
Ash	9.33 - 13.06	10.23 ± 1.42
Crude Fiber	11.76 - 15.69	14.94 ± 2.04
Carbohydrate	55.83 – 62.19	59.67 ± 3.57

Data represents the mean value of three replicates ±SD.

Nutritional evaluation

The nutritional evaluation of SSP is shown in Table (2). Such date indicated that the total energy was ranged 262.90 to 274.78 Kcal/100g, G.D.R. (g) for protein (63 g) was 1180.17 – 1281.11g, G.D.R. (g) for energy (2900 Kcal) was 1043.00 – 1104.76, P.S./ 100 g for protein (63g) was 7.69 – 9.02% and P.S./100 g for energy (2900 Kcal) was 8.90 – 9.77%. The nutritional evaluation reported was partially accordance with that observed by several authors (Abd Elalal et al., 2021; Elhassaneen, et al., 2021; Fayez, 2021). Therefore, SSP represents a low-calorie foods i.e. consumption of 100 g powder cover only 8.51 – 9.70% of the daily requirement of the adult person for energy. This phenomenon is attributed to their fat content, the high calories component, is generally low. In similar study, Nally and Junianto (2020) found that the fat content of brown algae was 0.19%. Also, several studies have determined a range of 0.50 to 0.79% (Manteu et al., 2018 ; Gazali et al., 2018). Such data confirmed that the possibility of successfully using of SSP in nutritional applications for obese and overweight patients.

Table 2. Nutritional value of SSP

Parameter	Range	Mean ± SD
Energy (Kcal/100g)	262.90 - 274.78	267.08 ± 5.67
G.D.R. (g) for protein (63 g)	1180.17 – 1281.11	1230.47 ± 45.78
G.D.R. (g) for energy	1043.00 –	1085.82 ±

(2900 Kcal)	1104.76	31.17
P.S./100 g (%) for protein (63g)	7.69 – 9.02	8.13 ± 0.63
P.S./100 g (%) For energy (2900 Kcal)	8.51 – 9.70	9.21 ± 0.47

Data represents the mean value of three replicates ±SD.

Phytochemistry and biological activity of Sargassum subrepandum powder (SSP)

Bioactive compounds

Bioactive compounds in SSP were shown in Table (3). Such data indicated that polysaccharides were the largest compound ranged 132.45 to 173.7 mg starch equvalent. g-1 followed by phenolics (103.66 to 158.98 mg gallic acid equvalent. g-1), carotenoids (27.84 to 49.17 mg.g-1), flavonoids (27.11 to 37.98 mg catechin equivalent. g-1) and anthocyanin's (5.91 to 8.03 mg Cyanidin 3-glucoside, CCy3G equivalent.100g-1). Also, brown algae (Sargassum subrepandum) were riched in dietary fiber ranged 38.05 - 46.42 g/100g. Several studies have confirmed that polysaccharides are major components and comprise alginates, cellulose, and sulfated polysaccharides such as fucoidans and laminarins (Chapman and Chapman, 1980 ; Helen, 2003; Abd Elalal et al., 2021; Elhassaneen et al., 2021). All of those compounds play significant roles in several food processing and human nutritional applications. For example, polysaccharides are used in food processing as thickeners, gelling agents, and emulsion stabilizers (Bixler and Porse, 2011). Also, alginates, the most frequently used of the brown algae extracts, are block copolymers of mannuronic and guluronic acid sugars that have been utilized as thickening agents in the food inustries and as binders, gelling agents, and wound absorbents in the pharmaceutical industry (Helen, 2003). In medical areas, polysaccharides increasingly gaining attention due to their several biological activities including anticoagulant, antithrombotic, anti- inflammatory, anti-obese, antiviral, immunomodulatory , and anti-osteoporosis effects (Fitton et al., 2008; Nagaoka et al., 2000; El-Gamal, 2020; Elhassaneen et al., 2020; Abd Elalal et al., 2021; Elhassaneen et al., 2021). Also, those compounds help protect against potential carcinogens and they clear the digestive system and protect surface membranes of the stomach and intestine (Gupta and Abu-Ghannam, 2011). Furthermore, polysaccharides exerts hypocholesterolemic and hypolipidemic effects through absorb substances like cholesterol then eliminated from the digestive system (Ito and Tsuchida, 1972; Burtin, 2003; Elhassaneen et al., 2022). This is often coupled with an increase in the faecal cholesterol content and a hypoglycaemic effect (Dumelod et al., 1999). Finally, Polysaccharides have shown good immunomodulatory properties associated with anti-tumor effects by algae (Wasser, 2002). Other bioactive constituents i.e. phenolics, flavonoids, carotenoids and anthocyanin's were determined in SSP which play several important biological roles in preventing and/or treating many diseases such as diabetes, atherosclerosis, cancer, obesity, bone, anemia aging and cardiovascular diseases (CVDs) (Elhassaneen et al., 2016 a, 2019, 2020, 2021; El-Gamal, 2020; Elhassaneen et al., 2022). This phenomenon is attributed to their magical biological/antioxidant activities. According to Santoso et al., (2004) phenolic compounds were spotted in several brown algae originating from various regions of Indonesia, and were assessed to effectively inhibit oxidation. Also, many different types of carotenoids were found in brown algae species intensifies platelet aggregation increasing the growth factor expression, which leads to the reconstruction of blood vessel walls (Kulczynski et al., 2017). Among other functions, those compounds are essential for maintaining the integrity of epithelial tissues, growth, and the proper functioning of the immune system (Nzamwita et al.,2017). For the health benefits of anthocyanins, Daotong et al., (2017) reviewed that several crucial cellular processes, such as cell cycle, apoptosis, autophagy, and biochemical metabolism, are involved in these beneficial effects. Finally, SSP were riched in dietary fiber (DF). DF are good for human health as they make an excellent intestinal environment by favoring the growth of intestinal microflora, including probiotic species so they can be considered as prebiotic (Tosh and Yada, 2010). In several cases, brown algae carbohydrates possess a fiber level greater than those recorded for many vegetables or fruits (Darcy-Vrillon, 1993; MacArtain et al., 2007; Elhassaneen et al., 2021). Hydrocolloids such as alginate, agar, carrageenans, fucoidan, and laminaran are abundant among the fibers found in brown algae. The value of consuming reasonable levels of DF for human health has been documented by several authors (Forsythe et al., 1976 and Ballesteros et al., 2001). They are primarily insoluble and can bind bile acids and lower plasma cholesterol (Camire et al. 1993 and Elbasouny et al., 2019). Also, El-Sadany (2001) reviewed that the hypocholesterolemic effect of DF, after four weeks of feeding on potato peels, rats showed 40 % reduction in plasma cholesterol content and 30% of hepatic fat cholesterol levels were reduced as compared with animals fed only with cellulose supplemented diet. Also, in both healthy and diabetic persons, a high intake of DF has a favourable impact on blood glucose profile and related health issues. DF can affect the absorption of other simple sugars by affecting the stomach emptying time. Many authors have also proven the effect of DF on blood glucose and insulin responsiveness (Chandalia et al., 2000; Al-Weshahy and Rao, 2012).

Table 3. Total content of bioactive compounds and dietary fiber in brown algae (Sargassum subrepandum)

Component	Range	Mean ± SD
Dietary fiber (g/100g)	38.05 - 46.42	42.56 ± 2.76
Phenolics (mg gallic acid equivalent. g-1)	103.66 - 158.98	137.45 ± 31.65
Flavonoids (mg catechin equivalent. g-1)	27.11 - 37.98	31.67 ± 4.92
Carotenoids (mg.g-1)	27.84 - 49.17	41.09 ± 10.73

Anthocyanin's (mg Cyanidin 3-glucoside, CCy3G equivalent.100g-1).	5.91 – 8.03	6.71 ± 1.02
Polysaccharides (mg starch. g-1)	132.45 – 173.76	161.34 ± 20.65

Data represents the mean value of three replicates ±SD.

Biological activities

Antioxidants activity (β -Carotene Bleaching, BCB)The decrease in absorbance of β-carotene in the presence of different SSP extracts and α-tocopherol used as standards with the oxidation of β-carotene and linoleic acid is shown in Figure (1). Such data indicated that SSP ethanol extract (SSP-EtE) recorded the lowest decreasing followed by SSP methanol extract (SSP-MtE) and SSP aquatic extract (SSP-AqE). The values of SSP-EtE and SSP-MtE absorbance's through 120 min are coming well i.e. closing to the line of 50 mg α-tocopherol compared with SSP-AqE. Also, such data proves the high stability of the SSP organic extracts when comparing with that most common antioxidant standards, α-tocopherol. The present data are in accordance with that obtained by El-Gamal, (2020) , Abd Elalal et al., (2021) and Elhassaneen et al., (2021) who found that different extracts of brown algae genus Sargassum have highly antioxidant activity. The higher antioxidant activity was recorded for the ethanol extract than hexane or water extracts. Also, several authors studied the antioxidant/BCB activity of many plant parts extracts by different media/solvents commonly distributed in the Egyptian local markets and recorded the same attention (Elhassaneen and Abd Elhady, 2014, Elhassaneen et al., 2016 and Aly et al., 2018). In general, BCB assay based on measured the ability of an antioxidant to inhibit lipid peroxidation. In this method, a model system made of β-carotene and linoleic acid undergoes a rapid discoloration in the absence of an antioxidant. The free linoleic acid radical formed upon the abstraction of a hydrogen atom (H+) from one of its methylene groups (-HC=CH-) attacked the β-carotene molecules, which lost the double bonds and therefore, its characteristic orange color. The absorbance of the solution at 470 nm was monitored on a spectrophotometer by taking measurements at 10 min intervals, and the rate of bleaching of β-carotene was calculated by fitting linear regression to data over time according to Marco (1968). Our previous studies indicated that such BCB method have been used as an efficiency technique for estimation/evaluation the antioxidant activity of huge plant parts extracts (Elhassaneen and Sanad, 2009; Elhassaneen and Abd Elhady, 2014; Shalaby, 2015; Sayed-Ahmed, 2016, Badawy, 2017, and Aly et al., 2018 and Elhassaneen et al., 2016, 2019 a-b, 2020-b).

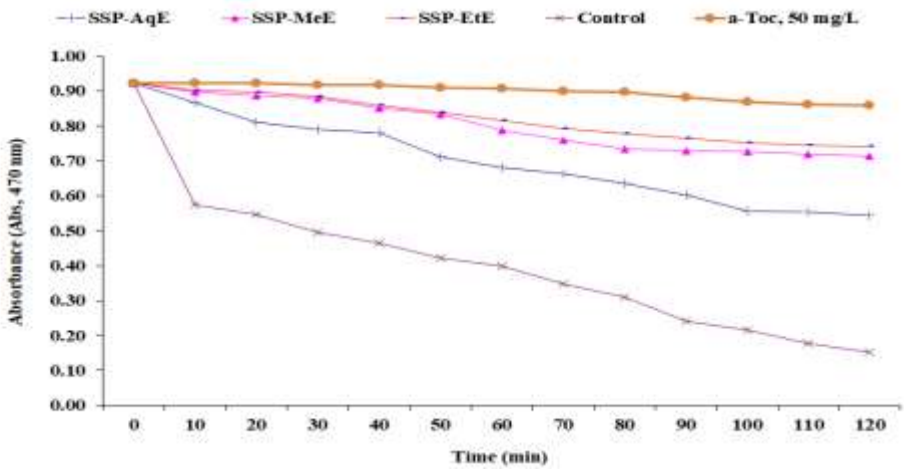

Figure 1. Antioxidant activity of different extracts of SSP assayed by the β-carotene bleaching method (Alpha–tocopherol at 50 mg/L concentration was used as a standard).

* SSP-AqE, Sargassum subrepandum powder aqueous extract, SSP-EtE, Sargassum subrepandum powder ethanol extract, SSP-MeOH, Sargassum subrepandum powder methanol extract, a-Toc, alpha-tocopherol standard.

DPPH radical scavenging activity

The free radical scavenging activity (FRSA) of the different extracts of SSP and standard BHT are shown in Figure (2) and Table (4). From such data it could be noticed that among the extracts, SSP-EtE possessed the highest activity. At a concentration of 100 µg/mL, the scavenging activity of SSP-AqE, SSP-EtE and SSP-MeE was 67.53, 82.53 and 79.09 %, respectively, whereas at the same concentration, the standard

BHT was 91.29 %. For the IC50, the SSP-AqE, SSP-EtE and SSP-MeE recorded 22.61, 11.12 and 12.34 µg/mL, respectively. The IC50 of BHT (standard) was 8.13 µg/mL. The FRSA of different tested extracts and standard was in the following order: BHT > SSP-EtE > SSP-MeE > SSP-AqE.

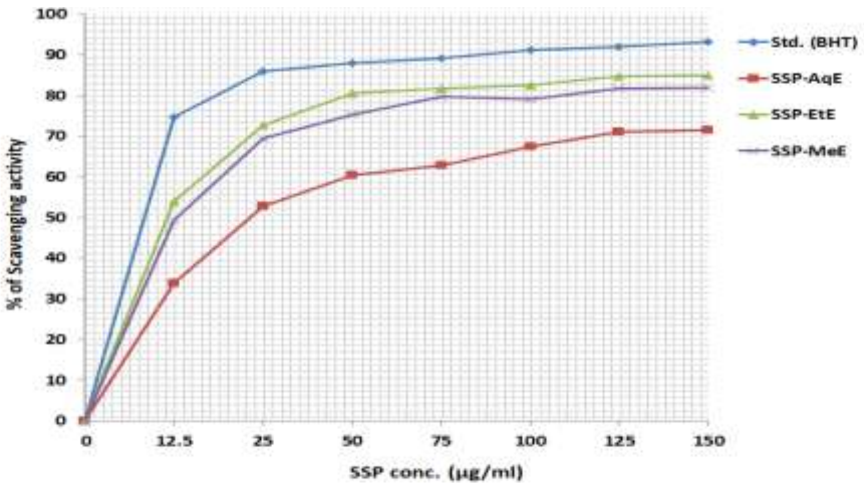

Figure 2. DPPH radical scavenging activity of SSP extracts

Each value represents the mean value of three replicates. * SSP-AqE, Sargassum subrepandum powder aqueous extract, SSP-EtE, Sargassum subrepandum powder ethanol extract, SSP-MeOH, Sargassum subrepandum powder methanol extract, BHT, butylated hydroxytoluene standard.

Table 4. IC50 (DPPH) of SSP extracts*

	BHT Std.	SSP-AqE	SSP-EtE	SSP-MeE
IC50 (µg/mL)	8.13 ± 0.51 c	22.61 ± 0.99a	11.12 ±1.02 b	12.34 ± 0.87 b

* Data represents the mean value of three replicates ±SD. Means with different superscript letters in the same raw are significantly did different at $p \leq 0.05$.

The theory of the DPPH radical scavenging activity test is based on measurement of diene conjugation by absorption at 234 nm is commonly used for determining the oxidative stability of a sample. The usual substrate for the determination of conjugated dienes is DDPH (2,2-diphenyl-1-picrylhydrazyl) (Antolovich and others 2002). DPPH methodology has been used successfully to evaluate the antioxidant activity of different parts including fruits, vegetables, algae, plant by-products etc. (Kahkonen et al.,1999). Several studied proved that FRSA are very important to prevent the adverse role of free radicals in different diseases such obesity, diabetes, cancer, cardiovascular, neurological, pulmonary, nephropathy diseases (Lien et al., 2008). The results obtained in this study suggest that all the extracts from BA showed FRSA which due to their rich content of different categories of bioactive compounds including phenolics, flavonoids, carotenoids etc.

In general, antioxidants may have a positive effect on human health as they can protect human body against damage by reactive oxygen species (ROS) and nitrogen oxygen species (NOS), which attack macromolecules including membrane lipids, proteins and DNA, lead to many health disorders including cancers, diabetes, heart vascular diseases, aging, inflammatory diseases, obesity, anemia, etc. (Halliwell and Aruoma, 1991; Yang et al., 2001, Salman, 2016; Mahran et al., 2018 and Aly et al., 2018; Elhassaneen et al., 2019 and 2021; Mehram et al., 2021 a and b). Additionally, deterioration of some foods has been identified due to oxidation of lipids or rancidity and formation of lipid peroxidation products causes a decrease in nutritional value of lipid foods, and affect their safety and appearance. Recently, there is a considerable interest for development of antioxidants from natural sources, such as marine algae (Isuru et al., 2011; El-Gamal, 2020 and Elhassaneen et al., 2020). They also reported that extracts from BA have induced immune-activity and also induced nitrite (NO) production.

In conclusion, data of the present study indicated that brown algae (Sargassum subrepandum) powder rich in nutrients (carbohydrates, ash, fiber and protein) and several categories of bioactive constituents including polysaccharides, phenolics, flavonoids, carotenoids, anthocyanin's etc., with other compounds that are responsible for different biological activities. The biological activities studied here including antioxidant and scavenging activities. Such important biological effects could play significance roles in strategies to combat/treat many diseases, especially those for which oxidative stress is one of the mechanisms for its occurrence. Therefore, we recommended like of that brown algae (Sargassum subrepandum) powder and/or extracts to be included in our daily diets/dishes, drinks, and pharmacological formulae.

Competing interest

Elhassaneen, YA, Elbassouny GM, El-Deeb, FA and Abd El-Rahman, SM., declare that they have no competing interest, and no financial support was received for the conduct of this study or preparation of this manuscript.

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تزامنت الفجوة / الأزمة الغذائية مع تفاقم الأدوية المخلقة كيميائيا في معظم دول العالم. لذلك، يتجه انتباه العالم إلى البحث عن أغذية غير تقليدية ومركبات نشطة بيولوجيًا من مصادر طبيعية. تهدف الدراسة الحالية إلى التحقق من الطحالب البنية (سرجاسم سبريبانديم) الموجودة على شواطئ البحار المصرية كمصدر قيم للمغذيات والمركبات النشطة بيولوجيًا ذات الأدوار البيولوجية / العلاجية الهامة. أشارت النتائج إلى أن الكربوهيدرات كانت أكبر مركب (٥٥.٨٣ - ٦٢.١٩٪) تليها الألياف الخام (١١.٧٦ - ١٥.٦٩٪)، الرماد (٩.٣٣ - ١٣.٠٦٪)، البروتين الكلي (٤.٧٤ - ٥.٩٥٪) والدهون الخام (٠.٥١ - ١.٠٧٪). في مسحوق (سرجاسم سبريبانديم). أيضا السكريات كانت أكبر مركب تراوحت نسبته بين ١٣٢.٤٥ إلى ١٧٣.٧ ملجم من النشا/جم .يليه الفينولات (١٠٣.٦٦ إلى ١٥٨.٩٨ مجم حمض الجاليك مكافئ /جم)، الكاروتينات (٢٧.٨٤ إلى ٤٩.١٧ مجم./جم)، الفلافونويد (٢٧.١١ إلى ٣٧.٩٨ مجم مكافئ الكاتشين /جم)، والأنثوسيانين (٥.٩١ إلى ٨.٠٣ مجم سيانيدين ٣-جلوكوزيد، CCy3G مكافئ / ١٠٠ جم) في نفس العينات. كما واجه هذا المحتوى العالي من المكونات النشطة بيولوجيًا في مسحوق (سرجاسم سبريبانديم) العديد من الأدوار البيولوجية المهمة مثل النشاط المضاد للأكسدة وأنشطة إزالة الجذور الحرة. كما تأثرت درجة النشاط البيولوجي بالاختلاف في وسط الاستخلاص، حيث سجلت المستخلصات العضوية (الميثانولية والإيثانولية) أعلى قيم للأنشطة البيولوجية، تلتها المستخلصات المائية. أصبحت درجة أنشطة المستخلصات العضوية جيدة، أي قريبة من قيمة ٥٠ مجم الالفاتوكوفيرول متبوعة بالمستخلصات المائية. في النهاية، يحتوى مسحوق (سرجاسم سبريبانديم) على مغذيات مختلفة ذات قيمة غذائية عالية ومكونات نشطة حيويا مسؤولة عن الأنشطة البيولوجية المختلفة بما في ذلك أنشطة مضادات الأكسدة وكسح الشقوق الحرة. لذلك، نوصي بإدراج مسحوق (سرجاسم سبريبانديم) في وجباتنا الغذائية / أطباقنا اليومية، والمشروبات، والمكملات الغذائية والتركيبات الدوائية.

الكلمات المفتاحية: مسحوق سرجاسم سبريبانديم ، التركيب الكيميائي، التقييم الغذائي، مضادات الأكسدة، الشاط الكسحى.