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Phytochemical variation, antioxidant and antidiabetic capacity of extracts of common brown seaweeds from the Red Sea, Egypt

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ABSTRACT

We investigated the phytochemical content and antioxidant properties of four brown seaweeds: *Cystoseira myrica*, *Dictyota spiralis*, *Sargassum euryphyllu*m, and *Turbinaria decurren*s. The antidiabetic potential of the α-amylase and α-glucosidase starch hydrolyzing enzymes of different brown algal extracts was also evaluated. All of the seaweeds analyzed had antioxidant effects, as assessed using 2,2-diphenyl-1-picrylhydrazyl (DPPH), reducing power, hydrogen peroxide radical scavenging, and total antioxidant capacity analyses, in addition to antidiabetic efficacy. These effects were influenced by the species and the solvent used. Among the three solvents, water extract had a higher content of phenol, tannins, and flavonoids than the other solvents, methanol and hexane. All extracts showed antioxidant activities which had a significant relationship with their phytochemical content. Water extract had greater antioxidant activity than the other extracts in all assays except the DPPH assay. Water extract of *T. decurrens* had the highest inhibitory effect on α-amylase and α-glucosidase. The best algal extracts were analyzed using gas chromatography–mass spectrometry (GC–MS), which revealed the existence of different compounds with various chemical structures. These compounds are known to have antioxidant and antidiabetic activities. It can be concluded that the prominent bioactive compounds found in brown algae have the potential to treat a wide range of serious diseases. The potential activities of specific biocompounds may be valuable in the pharmaceuticals, cosmeceutical, and functional foods industries.

INTRODUCTION

Seaweeds are eukaryotic organisms and are members of the Chlorophyta, Phaeophyta, and Rhodophyta, according to their chemical and nutrient composition. There are approximately 8000 macroalgal species on the world's coastlines, and they can live at depths of up to 270 m. Seaweeds are commercially important because of their biochemical content (**Chakraborty *et al*., 2014**). There are about 1500 brown species

have been identified worldwide (**Hoek *et al*., 1995**). Seaweeds, play significant roles in ecosystems, and have been used originally as food, and later as raw material for cosmetic, pharmaceutical, medicinal, and industrial purposes **(Krishnamurihy *et al*., 2013; Ismail *et al*., 2020),** because they contain biologically active compounds, such as polysaccharides, proteins, lipids, vitamins and minerals **(El-Said & El-Sikaily, 2013; Ganesan *et al*., 2019; El Zokm *et al*., 2021)**. Phenolic compounds from brown seaweed vary from simple molecules such as phenolic acids or flavonoids to highly complex polymers called phlorotannins, a subgroup of tannins formed by polymerization of phloroglucinol units via the acetate malonate pathway (**Cotas *et al*., 2020**). These compounds have recently attracted attention because of their wide diversity of biological functions (**Mekinić *et al*., 2019 & 2021**).

Seaweeds have been shown to have biological effects such as anti-hypertension, anti-hyperlipidemia, anticoagulant, antioxidant, anticancer, and anti-inflammatory effects **(Khalid *et al*., 2018; Ismail *et al*., 2020)**. Marine seaweeds are also used as a traditional source of natural antioxidant compounds **(Kokabi *et al*., 2013; Ismail *et al*., 2016)** that prevent or mitigate disease by scavenging free radicals and stopping or interrupting the oxidation process in cells. There are numerous artificial antioxidants, some of which have unsafe impacts. Brown seaweeds contain a significant concentration of phenolic substance with high biological efficiency, and more effective antioxidants than red and green species **(Ismail *et al*., 2016; El Zokm *et al*., 2021**). Seaweeds also play an important role as an antidiabetic factor by regulating glucose and starch hydrolyzing enzymes (**Husni *et al*., 2016**). Inhibition of these enzymes helps to decrease the digestion rate of carbohydrate and cause a reduction in the absorption rate, thereby lowering postprandial serum glucose levels **(Shailima Vardhini *et al*., 2013**). Brown seaweeds have been described as rich sources of biogenic substances with variety biological efficacies (**Mekinić *et al*., 2019**).

In this study we screened for biological compounds from brown algae, using different solvents. The correlation between the antioxidant and antidiabetic activity of the algae extracts' phytochemical profile was also investigated, in order to identify suitable solvents and species. We endeavored to identify the most bioactive compounds responsible for these activities using GC–MS analysis.

MATERIALS AND METHODS

1. Chemicals

All chemicals were pure and purchased from Sigma-Aldrich Chemie (Steinheim, Germany).

2. Collection and identification of seaweeds

Four fresh brown microalgae species were collected from Hurghada, Red Sea, Egypt during the winter of 2019, and were transported immediately to the taxonomy and

biodiversity laboratory on ice, where they were washed with tap water to remove epiphytes and non-living material. For taxonomical identification, several whole thalli were kept in 4% formalin, according to **Aleem (1993); Jha et al (2009)**. The species names were confirmed using **Guiry and Guiry (2021)**. The other samples were ground for further analysis after being shade =-dried at 38°C ± 2°C to a constant weight.

3. Preparation of algal extracts

Ten grams of each of the dried samples was extracted using 50 mL of 80% methanol, hexane, or distilled water for 72 h in shaking incubators in the dark at room temperature (29°C ± 2°C) for 24 h. The supernatant was collected after the tube had been centrifuged at 4500 g for 10 min. The extraction was repeated with 20 mL of the suitable solvent, and the two supernatants were combined. The supernatants were filtered, and each filtrate was concentrated in a rotary evaporator at a low pressure until it was completely dry. The residues were then subjected to two further extractions with water (2 mL each time) carried out for 30 min at 80°C, as recommended by **Cai *et al*. (2004**). Finally, the samples were kept in a refrigerator at 5°C± 3°C for use in the subsequent analyses.

4. Qualitative screening of phytochemicals

For the phytochemical screening of the various extracts of the obtained seaweeds, nine qualitative analyses were conducted. In these analyses, general reactions determined the presence or absence of tannins, terpenes, saponins, phlobatannins, steroids, flavonoids, coumarins, quinones, and cardiac glycosides in the various extracts using standard techniques **(Sadasivam & Manickam, 1992; Raaman, 2006)**.

5. Quantitative analysis of phytochemicals

The total phenolic content (TPC) of all extracts was measured using the Folin-Ciocalteu method (**Taga *et al*., 1984**). TPC values were expressed as mg gallic acid equivalent (GAE)/g DW. Tannins were determined using the colorimetric method reported by (**Chaudhuri *et al*., 2012**). Total flavonoids were estimated according to the method published by **Yang *et al.* (2004)**.

6. Biological activity

***6.1.* Determination of antioxidant activity**

The antioxidant ability of different extracts was estimated using four methods. The DPPH (1,1-diphenyl-2-picrylhydrazyl) radical scavenging activities of crude extracts were estimated by the method of **Yen & Chen (1995**), and were calculated using the formulas given by (**Duan *et al.*, 2006**). In all antioxidant analyses, α tocopherol was used as a positive control.

$$\text{DPPH \%} = \frac{(\text{Control OD} - \text{Sample OD})}{\text{Control OD}} \text{ X } 100$$

GraphPad Prism 6 software was used to determine the IC50 values (GraphPad Software, San Diego, California USA, www.graphpad.com). The total antioxidant capacity (TAC) of the algal extracts was detected using the **Prieto *et al.* (1999)** method. The ferric reducing antioxidant power of the extracts was determined according to the method published by **Oyaizu (1986)**. Results were presented as mg of ascorbic acid /g dry weight (mg AAE/g DW). Hydrogen peroxide radical scavenging activity (HPA) was measured according to **Ebrahimzadeh *et al.* (2010)**.

6.2. Determination of antidiabetic activity *in vitro*

The antidiabetic activity of the algal extracts was assayed using the inhibitory activity of α-amylase and α-glucosidase, using the protocols of **Dong et al. (2012)**; **Prabhakar *et al*. (2013),** respectively.

The inhibition activity of both enzymes was calculated using the following equation:

$$= \frac{(\text{Enzyme activity of control} - \text{Enzyme activity of Sample})}{\text{Enzyme activity of control}} \text{ X } 100$$

The doses of the most promising extract resulting in 50% inhibition of the enzyme ability (IC_{50}) were estimated using GraphPad Prism 6 software.

7. Gas chromatography–mass spectrometry

The compounds comprising the most active extract were determined using GC–MS (Agilent 6890 GC coupled to an Agilent 5975 quadrupole mass detector; Agilent Technologies, Santa Clara, CA, USA) (**Rahman *et al*., 2004**).

8. Statistical analysis

For all experiments, data were reported as mean ± standard deviation (SD) (n = 3) using SPSS software 30, 2020. The statistically significant difference between the studied seaweeds activities was detected using analysis of variance (one-way ANOVA). Pearson's correlation coefficients were used for determining the relationships between the phytochemical contents of different algal extracts and their biological activities.

RESULTS AND DISCUSSION

1. Identification of the collected seaweeds

The present seaweeds were taxonomically identified as *Cystoseira myrica* (S.G.Gmelin) C. Agardh, *Dictyota spiralis* Montagne, *Sargassum euryphyllum* (Grunow) Tseng & Lu Baoren, and *Turbinaria decurrens* Bory (Fig. 1).

2. Phytochemical analysis of the algal extracts

As shown in Table "1", there were secondary bioactive metabolites like phenols, tannins, flavonoids, alkaloids, steroids, quinines, and carbohydrates in almost all tested extracts. Phlobatannins, glycosides, saponins, and coumarins were rare. These substances seemed to vary depending on the solvent used and the types of seaweed tested. Water and methanol extracts contained more compounds than hexane extracts. The presence of these

biocompounds in different extracts may be responsible for their biological efficiencies, and they may work synergistically to monitor antioxidants and antidiabetic functions **(Sanger *et al.*, 2019**). Some of these compounds have been reported in extracts from the species *Turbinaria conoides* (**Mohapatra *et al.*, 2016**).

Cystoseira myrica

Dictyota spiralis

Sargassum euryphyllum

Turbinaria decurrens

Figure 1. The brown seaweed used in the study

Table 1. Qualitative phytochemicals contents of different seaweed extracts

Seaweeds / Solvents	*C. myrica*			*D. spiralis*			*S. euryphyllum*			*T. decurrens*		
	H	**M**	**W**	**H**	**M**	**W**	**H**	**M**	**W**	**H**	**M**	**W**
Alkaloide	+	+	++	+	+	++	+	+	++	+	+	++
Phenolic	+	+	+	+	+	+	+	+	+	+	+	+
Flavonoid	+	+	++	+	+	++	+	+	++	+	+	++
Carbohydrate	-	+	++	-	++	++	-	++	++	-	++	++
Tannins	+	+	++	+	+	++	+	+	++	+	+	++
Phlobatannin	-	-	-	-	+	+	-	+	+	-	+	+
Steroid	-	-	++	+	++	+	+	++	+	+	++	+
Glycosides	-	+	-	-	+	-	-	+	-	-	+	-
Quinones	-	-	++	-	++	++	-	++	++	-	++	++
Coumarins	-	+	-	+	++	-	+	++	-	+	++	-
Saponins	+	-	+	+	-	+	+	-	+	+	-	+

Table 2. Phytochemical content (mg/g DW) of different seaweed extracts

solvent	**Phenol** (mg GAE/g DW)				**Tannins** (mg GAE/g DW)				**Flavonoid** (mg catechin equivalents/g DW)			
	Cy myrica	***D. spiralis***	***S. euryphyllum***	***T. decurrens***	***Cy myrica***	***D. spiralis***	***S. euryphyllum***	***T. decurrens***	***Cy myrica***	***D. spiralis***	***S. euryphyllum***	***T. decurrens***
Water	48.88[a]	40.74[b]	45.86[a]	34.62[c]	1.491[a]	1.867[a]	1.658[a]	1.284[b]	29.64[c]	31.99[b]	27.15[c]	40.9[a]
Methanol	20.25[b]	34.56[a]	30.16[a]	18.18[b]	0.654[b]	1.527[a]	0.364[c]	0.582[b]	18.47[b]	14.37[c]	21.49[a]	15.19[c]
Hexane	17.77[a]	18.59[a]	19.83[a]	16.12[a]	0.873[a]	0.545[b]	0.073[c]	0.509[b]	12.78[c]	16.53[a]	14.64[b]	10.89[d]

Overall, the TPC of *Cy. myrica* ranged from 48.88 mg/g DW in water extract to 20.25 and 17.77 mg equivalent GAE/100 g DW in methanol and hexane extract, respectively. The phenolic content of brown seaweed is affected by different abiotic and biotic parameters, including the solvent used and the storage conditions **(Shrestha *et al*., 2021**). The aqueous extract had higher TFC than methanol and hexane for all investigated species. Samples extracted with water had two-fold higher TFC and more than three-fold higher TTC than samples extracted with methanol or hexane. A similar pattern was detected by **Altemimi *et al.* (2017)**, who found that water was superior to methanol and hexane for isolating biomolecules from plants. However, the amount of tannins extracted from *D. spiralis* by methanol was higher than that obtained using water or hexane. Although studies into the flavonoid content of algae are limited, some reports have shown evidence of *P. pavonica* extracts being rich in flavonoids (70.08 mg/g rutin equivalent) using microwave assisted extraction (**Alghazeer *et al*., 2017**). Phenolic compounds from plants like flavonoids and tannins are known to be natural antioxidant substances (**Suffredini *et al*., 2004**).

3. Antioxidant activity

The antioxidant activity of the extracts was determined using the DPPH, TAC, R.P., and peroxidase assays. The scavenging activity is the ability of the compound to react preferentially with free radicals. The DPPH scavenging activity of the three solvents, expressed as IC_{50} values, is illustrated in Figure "2". Lower IC_{50} concentrations indicate higher scavenging activity. Generally, the aqueous extracts showed the highest antioxidant activity in all antioxidant analyses except the DPPH assay, while the methanol extract of *T. decurrens* recorded the highest inhibition ratio, 64.88%, followed by *D. spiralis* at 64.73%, followed by aqueous extract of *T. decurrens* at 62.98%. The polarity of the solvents was important to the DPPH inhibition of crude extracts (**López *et al*., 2011**). **Altemimi *et al*. (2017)** reported methanol extracts showed the highest DPPH activity, followed by ethyl acetate and aqueous extracts, although they had lower phenol contents. **Yin e*t al*., (2008)** reported that methanol extract produced better reduction of DPPH radicals than water extract. The IC_{50} value of methanol extracts was lower than that of ascorbic acid (3.2 mg/g), indicating that methanol extract was a better DPPH scavenger than water and hexane (Fig. 2). The water extract of *T. decurrens* had the highest TAC (0.945 mg AAE/g DW) and HPA (33.18%), followed by their methanolic extract, with 0.9125 mg AAE/g DW and 30.01%, respectively (Figures 3 and 5). *T. decurrens* (0.945 mg AAE/g DW), *D. spiralis* (0.927 mg AAE/g DW) and, *Cy. myrica* (0.912mg AAE/g DW), showed non-significant reducing activity (Fig. 4).

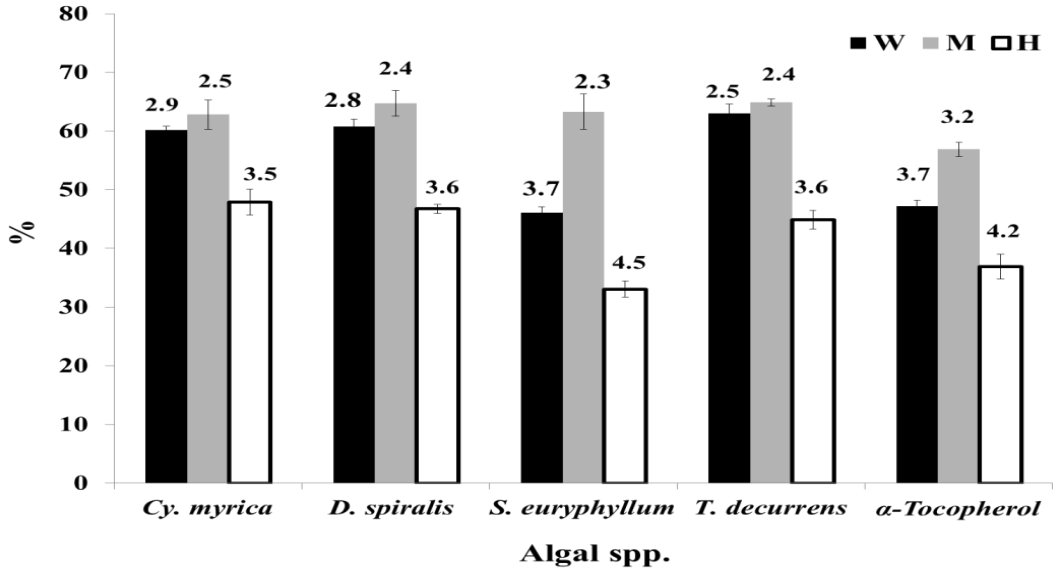

Figure 2. DPPH of the tested seaweed extracts. Upper values reflecting the IC50 (mg/g).

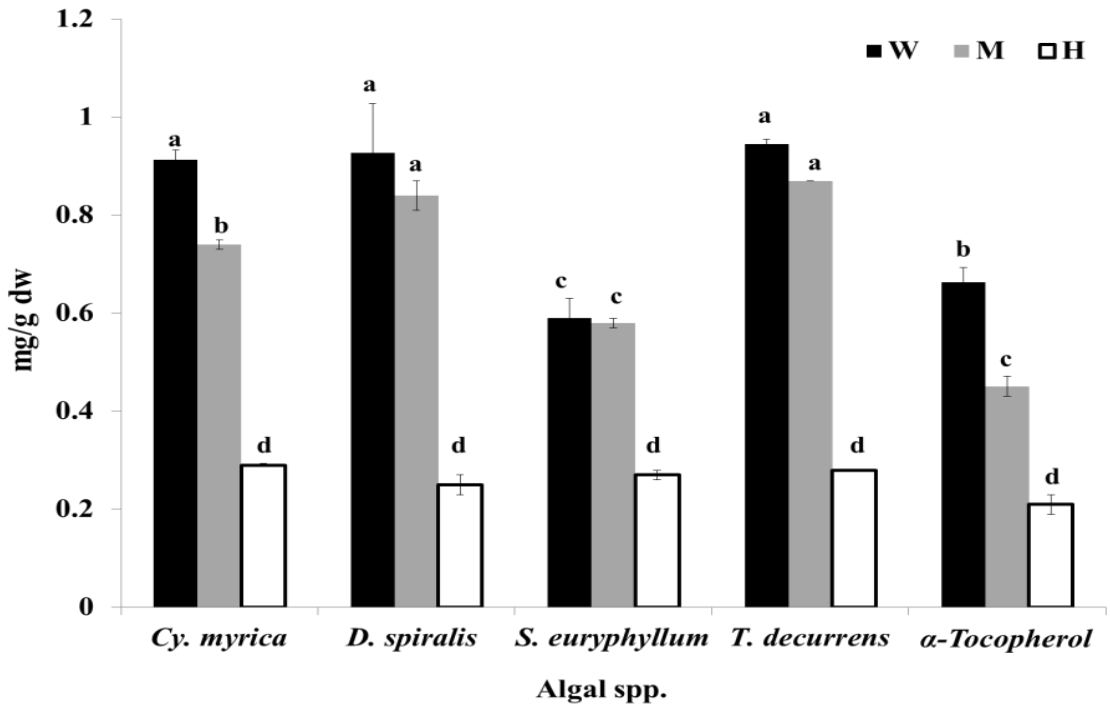

Figure 3. Total antioxidant activity of different tested extracts. Upper letters are significantly different at $p < 0.05$

These variations in antioxidant activity between different brown algal extracts may be related to the polarity of the used solvents and the algal species.

Generally, hexane extracts of all algae tested had the lowest antioxidant activities in all assays. The results shown in Table "3" indicate a significant correlation between the antioxidant activity and the TPC, TFC, and TTA. This result is in agreement with those of **Ismail *et al*., (2016); Cotas *et al*. (2020); Lomartire *et al*. (2021)**.

Table 3. Matrix of simple linear correlation coefficient (r) between phytochemicals content and biological activities of different seaweed extracts

	TPC	TTC	TFC	FTAP	HPA	DPPH	TAC	α-Amylase	α-Glucosidase
TPC	1								
TTC	**0.817**	1.000							
TFC	**0.716**	**0.739**	1.000						
FTAP	**0.857**	**0.863**	**0.766**	1.000					
HPA	**0.679**	**0.642**	**0.803**	0.569	1.000				
DPPH	**0.723**	-0.339	**0.761**	-0.295	-0.026	1.000			
TAC	**0.727**	0.508	0.166	0.329	0.120	0.372	1.000		
α-Amylase	-0.116	0.058	0.328	**0.748**	-0.003	-0.066	-0.005	1.000	
α-Glucosidase	**0.783**	**0.755**	**0.904**	**0.826**	**0.630**	0.026	0.051	0.393	1

*** Correlation is significant at the 0.05 level.**

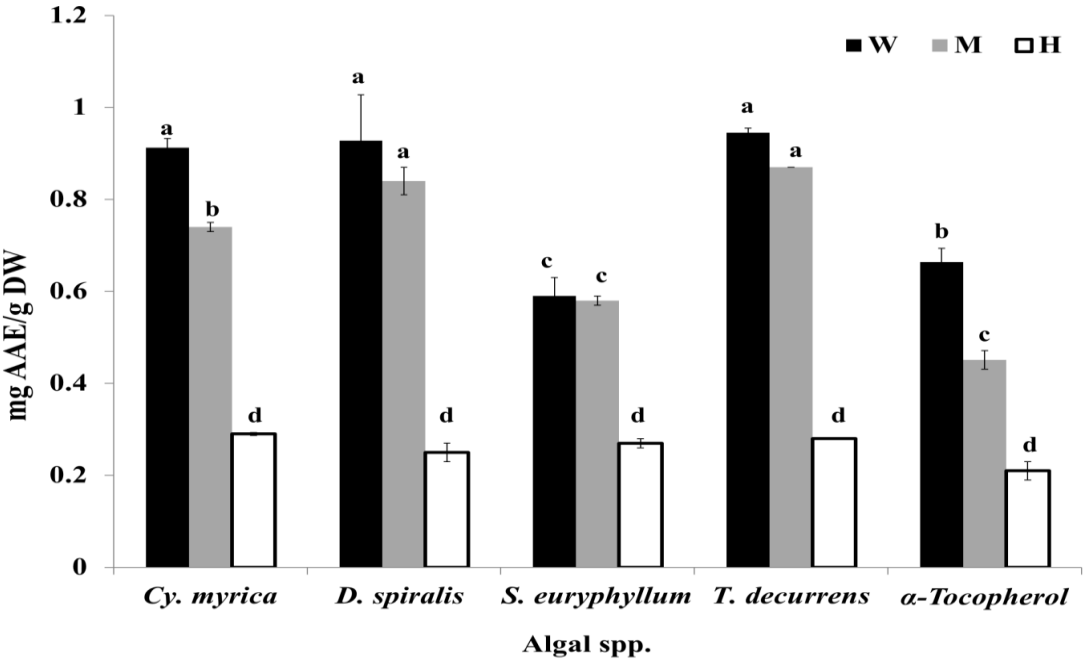

Figure 4. Total reducing activity of seaweed extracts. Upper letters are significantly different at $p < 0.05$

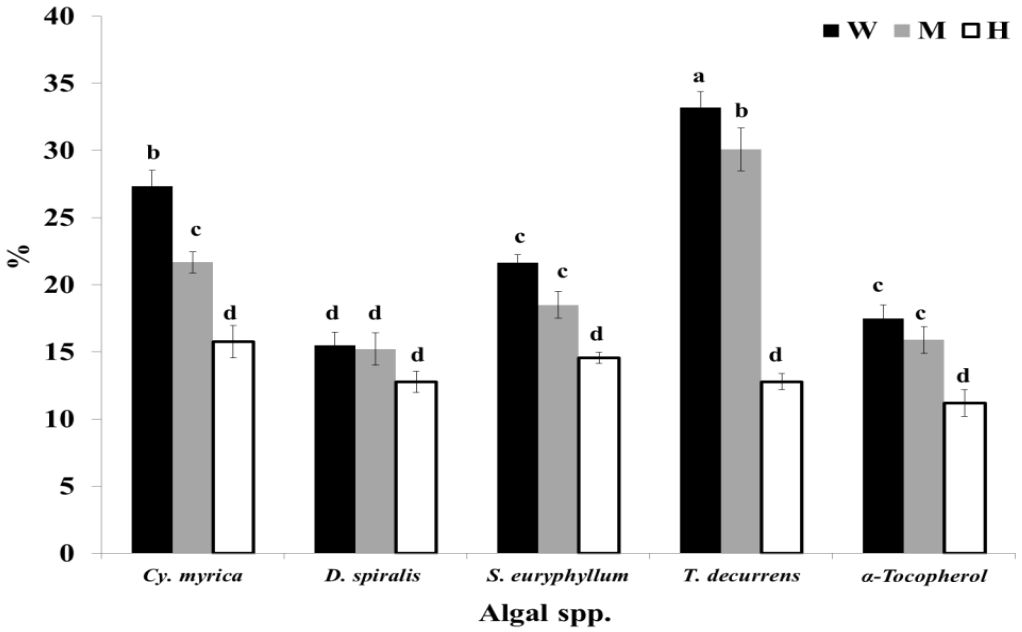

Figure 5. Hydrogen peroxide radical scavenging activity of the extracted seaweed. Upper letters are significantly different at $p < 0.05$

4. α-amylase and α-glucosidase enzymes

Diabetes mellitus is a complex disease characterized by chronic hyperglycemia related to a decrease in insulin secretion, or resistance to insulin (**Nickavar & Yousefian, 2011**). Enzymes like α-amylase and α-glucosidase act together to hydrolyze starch by pancreatic α-amylase then to absorb glucose by intestinal α-glucosidase which may regulate postprandial hyperglycemia (**Unnikrishnan *et al*., 2015**).

Figure "6" illustrates the inhibitory effect of *Cy. myrica*, *D. spiralis*, *S. euryphyllum*, and *T. decurrens* on *α*-amylase and *α*-glucosidase *in vitro*. The extracts were ranked water > methanol > hexane for *α*-amylase and *α*-glucosidase in *D. spiralis* and *T. decurrens*. *Cy. myrica* recorded methanol > hexane > water (93.68%, 84.96%, and 77.99%, respectively) for *α*-amylase. The *α*-glucosidase inhibitory activity was water > methanol > hexane. Different *S. euryphyllum* extracts showed non-significant *α*-amylase effects. All extracts tested exhibited both *α*-amylase and *α*-glucosidase inhibitory activity, and each solvent had a non-significant difference compared with a standard drug, acarbose. The methanol extract of *S. polycystum* (96%) and ethyl acetate extract of *S. wightii* (91%) showed more effective inhibition of α-glucosidase than acarbose (**Unnikrishnan *et al*., 2015**). The highest inhibitory effects were for α-amylase (95.12%) with an IC_{50} value of 2.9 mg/g DW, compared to an acarbose positive control (3.01) and α-glucosidase (83.31%) with 3.17 an IC_{50} value compared to acarbose (3.21). Similarly, **Chin *et al*. (2020**) demonstrated that a water extract of the brown algal species *Padina* and *Sargassum* improved insulin resistance, decreased hyperglycemia, and protected the liver and pancreatic tissue from HFD-induced damage in mice. **Chin *et al*., (2015)**

recorded the α-glucosidase inhibitory activity of crude aqueous extracts of the brown algae species *Turbinaria conoides*, *Padina sulcata*, and *Sargassum binderi*.

Marine algae have been a source of many medicines, since algal extracts are known to be effective inhibitors of α-amylase, α-glucosidase, and DPP-IV, due to the presence of various phytochemicals which bind to active sites and alter the catalytic activity of enzymes (**Gunathilaka *et al*., 2021**). As shown in Table "3", the antidiabetic activity of the macroalgal extracts might be due to the presence of various phytochemical substances like polyphenols, which bind to the active sites of the enzymes involved in diabetes and alter their catalytic activity, so the antidiabetic activity is correlated to the antioxidant activity **(Ismail *et al*., 2020**).

The phenols and flavonoids isolated from macroalgae are characterized by high antioxidant activity, which may lead to intracellular damage and a high level of reactive oxygen species (ROS) generation in infected pathogens (**Rajivgandhi *et al*., 2021**). Flavonoid compounds have been investigated from a medical perspective, such as the antidiabetic area (**Hussain *et al*., 2020**).

Along with these studies, the present investigation adds strong supporting evidence that members of the species *Cy. myrica*, *D. spiralis*, *S. euryphyllum*, and *T. decurrens* are an excellent source of α-amylase and α-glucosidase. The use of these extracts as food additives may reduce the activity of intestinal enzymes such as α-amylase and α-glucosidase, and may delay the degradation of the incretin hormones GLP-1 and GIP, which could stimulate insulin production and decrease glucagon release, and stimulate the regeneration and differentiation of β-cells, which could enhance glucose homeostasis and prevent hyperglycemia (**Pirian *et al*., 2017**).

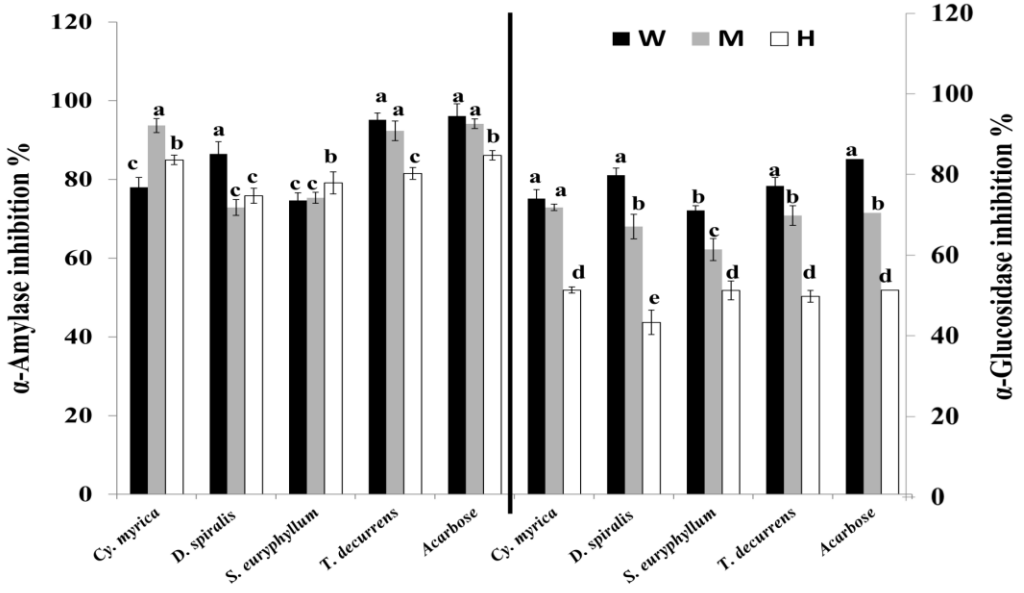

Fig. 6. α-Amylase and α-glucosidase inhibitory activity of different seaweeds extracts *in vitro*

6- Gas chromatography–mass spectra analysis

The bioactive contents of the most active algal extracts, water extract of *T. decurrens* and methanol and hexane extracts of *Cy. myrica* were studied using GC–MS. The name, molecular formula, retention time, and area of the components from the different extracts are shown in Table 4. The methanolic extract of *Cy. myrica* contained a higher number of organic compounds (17 compounds) than the hexane extract of *Cy myrica* (12 compounds) or the water extract of *T. decurrens* (6 compounds) that might contribute to the biological activity of these seaweeds. The variation in the ratio and number of bioactive compounds in different extracts depended on the algal species and the solvents used.

D-Mannitol, a 6TMS derivative, is a major polyphenol compound in both water (18.702%) and methanol (12.16%) extracts which contain six-carbon polyhydroxy alcohol (polyhydric alcohol; polyol; sugar alcohol) produced by many organisms, including plants, algae, lichens, bacteria, and fungi, in which it was first discovered by Henri Braconnot in 1811 (Cochrane, 1958; LEWIS & SMITH, 1967). It has been shown to quench ROS both *in vitro* and *in vivo*. The 2-Pentadecyn-1-ol is the main compound in methanol and hexane (40.36%) extracts, and has antioxidant, anti-inflammatory, and antimicrobial properties **(Vimala & Shoba, 2019**). 3-decyn-2-ol (23.21%) and 4-chloro-3-n-butyltetrahydropyran (14.67%) are major components of *Cy. myrica* hexane extract, and exhibit antimicrobial activity **(Doughari & Abraham, 2021**).

The lipid composition of marine algae has attracted the attention of researchers due to the high content of polyunsaturated fatty acids like 9,12,15-octadecatrienoic acid, 2,3-dihydroxypropyl ester, (Z,Z,Z)-, 8,11,14-eicosatrienoic acid, methyl ester, (Z,Z,Z), and 6,9,12,15-docosatetraenoic acid, methyl ester. These types of fatty acids are considered to be essential nutritional components for humans and animals, playing an important role in preventing diabetes and cardiovascular disease, and also having antiviral, antimicrobial, anti-inflammatory, antitumor, and antioxidant activities (**Kendel *et al.*, 2015**). Palmitic acid, a TMS derivative, is a saturated fatty acid, and acts as an antioxidant (**Elagbar *et al.*, 2016**). α-D-glactopyranose, a 5TMS derivative, is the dominant monosaccharide, and was present in different ratios in all extracts exhibiting antioxidant activity (**Ding *et al.*, 2015**). The 2-deoxypentofuranose, a 3TMS derivative, is a major compound in the water extract of *T. decurrents* (18.46%) derivatives that contain hydroxyl groups and have antioxidant activity (**Mohamed & Khan, 2013**). Ergosta-5,22-dien-3-ol, acetate, which has antioxidant properties, was detected in methanolic extract only (3.1%) (**Mohammed *et al.*, 2016**). Glycerol, a 3TMS derivative, and 1-monopalmitin, a 2TMS derivative, were present in amounts of less than 1%, and are characterized by antioxidant activity (Nobre *et al*., 2020). Most phytochemicals detected in the selected extracts are known to have antioxidant effects, and play vital roles in controlling diabetic complications, while ROS cause several diseases, such as diabetes (**Mohapatra *et al.*, 2016**).

Table 4. GC–MS characterization of the most active seaweed extracts

Retention Time	Name of the compound	Chemical formula	Area %		
			Water extract of *T. decurrens*	Methanol extract of *Cy. myrica*	Water extract of *Cy. myrica*
11.02	Glycerol, 3TMS derivative	$C_{12}H_{32}O_3Si_3$		0.79	
16.09	2,6,6-Trimethyl-bicyclo[3.1.1]hept-3-ylamine	$C_{10}H_{19}N$		3.76	4.26
16.69	D-Mannitol, 6TMS derivative	$C_{24}H_{62}O_6Si_6$	18.702	12.16	
17.05	4-Chloro-3-n-butyltetrahydropyran	$C_9H_{17}ClO$		3.26	14.67
17.32	β-L-(-)-Fucopyranose, 4TMS derivative	$C_{18}H_{44}O_5Si_4$		3.13	
18.48	α-D-Glactopyranose, 5TMS derivative	$C_{21}H_{52}O_6Si_5$	0.92	8.32	2.83
18.64	2-Deoxypentofuranose, 3TMS derivative	$C_{14}H_{34}O_4Si_3$	18.46		
19.12	D-Mannopyranose, 5TMS derivative	$C_{21}H_{52}O_6Si_5$		1.02	
19.48	Palmitic Acid, TMS derivative	$C_{19}H_{40}O_2Si$	17.85	6.2	
20.01	2-Pentadecyn-1-ol	$C_{15}H_{28}O$		27.4	40.36
20.22	1-Oxacyclopropyl-3,4-epoxycyclohexane	$C_8H_{12}O_2$	0.75	13.81	
20.255	3-Decyn-2-ol	$C_{10}H_{18}O$			23.21
20.65	2-Decyn-1-ol	$C_{10}H_{18}O$		1.61	4.76
21.02	8,11,14-Eicosatrienoic acid, methyl ester, (Z,Z,Z)-	$C_{21}H_{36}O_2$	19.06	2.09	
23.71	6,9,12,15-Docosatetraenoic acid, methyl ester	$C_{23}H_{38}O_2$		2	1.79
23.98	1-Monopalmitin, 2TMS derivative	$C_{25}H_{54}O_4Si_2$		0.59	4.43
24.45	Ergosta-5,22-dien-3-ol, acetate, (3β,22E)-	$C_{30}H_{48}O_2$		3.1	
24.71	9,12,15-Octadecatrienoic acid, 2,3-dihydroxypropyl ester, (Z,Z,Z)-	$C_{21}H_{36}O_4$		6.19	2.9
25.46	Glycerol monostearate, 2TMS derivative	$C_{27}H_{58}O_4Si_2$		4.56	0.79

CONCLUSION

The seaweeds *Cy. myrica*, *D. spiralis*, *S. euryphyllum*, and *T. decurrens* were collected from Hurghada, Egypt, and almost all tested extracts were rich in phenols, flavonoids, alkaloids, tannins, steroids, quinones, and carbohydrates. The antioxidant activities of different solvents of these seaweeds showed solvent dependency *in vitro*. In general, water and methanol extracts of the seaweeds had higher antioxidant activity than hexane extracts. The present findings suggest that water extract of the tested seaweeds may have the potential for treating diabetes by inhibiting glucosidase activity, due to the phenolic compounds and other pharmaceutical compounds which they contain. The antidiabetic effects of these extracts may be due to their underlying antioxidant activity. Algae can be used as a functional food which may prevent or delay complications related to diabetes. Further analyses should be performed to identify the phenolic profiles of the extracts, and the seasonal effect on phytochemical content, as well as their biological potential.

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