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SCREENING OF PHYTOCHEMICALS, FATTY ACID COMPOSITION AND *IN-VITRO* ANALYSIS OF ANTIOXIDANT PROPERTY OF GREEN EDIBLE SEAWEED *CAULERPA LENTILLIFERA* (FAMILY: CAULERPACEAE)

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Keywords:

Edible seaweed, *Caulerpa lentillifera*, Phytochemicals, Fatty Acid Composition, Antioxidant properties

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ABSTRACT: Marine algae are one of the largest producers of biomass in the marine environment. They produce a wide variety of chemically active metabolites in their surroundings, potentially as an aid to protect themselves against the other settling organisms. These seaweeds are an immense source of bioactive molecules for the exploration of novel drugs. The present investigation deals with the screening of phytochemical composition, fatty acid composition and antioxidant activity of the green edible seaweed *Caulerpa lentillifera* (Family: Caulerpaceae) (TSN: 6973 & APHIA ID: 211475). The seaweed was collected from Mandapam Coast, Tamil Nadu, different solvents were used for the preparation of seaweed extract. The Phytochemical constituents of seaweeds, such as carbohydrate, protein, tannins, phytosterols, glycosides, alkaloids, flavonoids, diterpenes, resins and saponins of *C. lentillifera* were analyzed using standard methods. Fatty acid profile was investigated using Gas chromatography Mass spectrometry (GC-MS). Various fatty acid components are analyzed using GC-MS and nearly 35 components were recorded. In the present investigation, the *in-vitro* analysis of antioxidant property has been confirmed. From this study, it is evident that *Caulerpa lentillifera* contains various bioactive compounds and can be recommended as seaweed of phytopharmaceutical importance. The seaweed extracts showed high antioxidant activity which is influenced by its phytochemical and fatty acid contents.

INTRODUCTION: As more than 70% of the world's surface is covered by oceans, the wide diversity of marine organisms offer a rich source of natural products [1, 2]. Marine algae are one of the largest producers of biomass in the marine environment [3-6]. They produce a wide variety of chemically active metabolites in their surroundings, potentially as an aid to protect themselves against the other settling organisms.

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These active metabolites, also known as biogenic compounds, such as halogenated compounds, alcohols, aldehydes, and terpenoids are produced by several species of marine macro and microalgae. They have antibacterial, antioxidant, antifouling, and antifungal properties, which are effective in the prevention of biofouling and have other likely uses, as in therapeutics [6-13].

Green seaweed from the genus of Caulerpa consists of one cell by many nuclei, often found in tropical and subtropical waters [14, 15]. *Caulerpa lentillifera* is commonly used as food for human [16]. It is popular as a human food because of its nutritional value such as iodine, vitamins A and C, minerals and others [17]. It is favored by the consumers because of its soft, succulent grape-like structure.

However, these sea grapes are known as an efficient bio-filter that has the ability to accumulate contaminants from its sources. Fatty acids derived from marine organisms differ in chemical structures which served as a biological marker. It has the ability of biological activity due to the characteristic of living environment [18].

Several studies have reported the activity of essential fatty acids from seaweed. ω-3 and ω-6 obtained from *Undaria pinnatifida* could act as an anti-inflammatory and pro-inflammatory agents [19-22]. The Fatty acids such as Hexadecatetraenoic acid (HDTA) C16:4 ω-3, octadecatetraenoic acid (ODTA) C18: 4 ω-3, linoleic acid (LA) C18: 2 ω-6 and α-linolenic acid (ALA) C18: 3 ω-3 derived from *Ulva pertusa* and *Ulva fasciata* these components were known to have algicidal activity [23]. Antioxidants have multiple functions in biological systems, including the defense against oxidative damage and participation in the major signaling pathways of cells. One major action of antioxidants in cells is to prevent damage caused by the action of reactive oxygen species [24-27]. Free radicals are responsible for aging, and their presence in excess constitutes the cause of various human diseases. Different studies have shown that, antioxidant substances which scavenge free radicals and play an important role in the prevention of free radical-induced diseases [28-31]. This action helps in protecting the body from degenerative diseases. In the present investigation, the screening of phytochemicals, fatty acid composition and antioxidant properties of seaweed *C. lentillifera* have been carried out.

MATERIALS AND METHODS:

Sample Collection: Fresh marine seaweed *Caulerpa lentillifera* (TSN: 6973 & APHIA ID: 211475) was collected from the Mandapam coast, Tamil Nadu, India. The collected sample was washed with tap water to remove epiphytes and other marine organisms then washed with distilled water and dried at room temperature. The dried seaweed was sieved and made into powder.

Preparation of Seaweed Extract for Screening of Phytochemicals Constituents: The extract was prepared using different solvents such as chloroform, methanol, DMSO and distilled water. About 200 mg of seaweed powder was mixed with different solvents separately and extracts were prepared using the Soxhlet Apparatus. Each extraction was carried out in a Soxhlet apparatus for 24 h, and after evaporation, in a vacuum, the extracts were stored at -20 ºC until use [32].

Preparation of Seaweed Extract for Analysis of Antioxidant Activity: About 10 gm of plant powder was mixed with 10 mL of Dimethyl Sulfoxide (DMSO). The mixture was stirred for 24 hours in a magnetic stirrer. Then the mixture was filtered by vacuum filtration. The filtered solid was dried at 80 ºC for 24 h. After complete drying, the solid was weighed; from this weight, the dissolved crude seaweed extract in the filtrate was calculated.

Phytochemical Analysis: The Phytochemicals constituents of seaweed, such as carbohydrate, protein, tannins, phytosterols, glycosides, alkaloids, flavonoids, diterpenes, resins and saponins of *C. lentillifera* were analyzed using standard methods [33-36].

Determination of Antioxidant Activity: The antioxidant activity in an extract of *C. lentillifera* was determined by the following assays.

DPPH Free Radical Scavenging Assay: The DPPH radical scavenging activity of crude extract can be determined on the basis of the capacity to scavenge stable 1, 1-diphenyl 2-pierylhydrazyl (DPPH) radical [37]. The absorbance of DPPH radical is 517 nm in the UV-Visible Spectrum and hence, the scavenging capacity measured by this method. In this method, a decrease in the absorbance of DPPH radical, because of the formation of stable DPPH molecule.

Ascorbic acid was used as a standard. The stock solution of DPPH (0.1 mM) in DMSO has been prepared. 2 ml of the stock solution was added to the 2 mL of DMSO (containing sample) and the absorbance was recorded at 517 nm. The percentage of inhibition has been calculated from the blank and test solution. DPPH of the solution has taken as a negative control. The % inhibition was calculated using the formula given below.

$$\% \text{ Inhibition} = [(Ac-At)/Ac] \times 100$$

Where, Ac: Absorbance of control, At Absorbance of test

Assay of Total Antioxidant Capacity: The assay of total antioxidant capacity of the seaweed extract was conducted according to the method of Prieto, *et al.*, (1999). About 3 ml of antioxidant reagent (0.6 M H_2SO_4, 28 mM Na_3PO_4 and 4 mM ammonium molybdate) were added to the test samples with various concentrations such as 10, 50, 100, 250 and 500 µg/ml. The test mixture to accomplish proper diffusion with phosphomolybdenum reagent was incubated at 95 ºC for 90 minutes in a water bath. The total antioxidant activity of extracts and vitamin C (Ascorbic acid) the standard drug was measured and determined their absorbance at 695 nm using a spectrophotometer. The total antioxidant activities were calculated using the formula.

$$TOA = [(At-Ac) /At] \times 100$$

GC – MS analysis of Fatty Acid Profile: The Gas Chromatography and Mass Spectrometry (GC-MS) analysis were done in order to know the components of the experimental samples. The components were analyzed by GC-MS (SHIMADZU QP 2010) employing the electron impact (EI) mode at an ionizing potential of 70 eV with a 30 m × 0.32 mm film thickness and 1.8 µm capillary column (Resteck-624 MS) packed with 5% phenyl dimethyl silicone at an ion source temperature of 200 °C. For further analysis, GC-MS settings were as follows: the initial column temperature was set at 45 °C and held for 4 min.

The temperature was raised to 50 °C and then increased up to 175 °C at a rate of 10 ºC/min for 2 min and then finally programmed to 240 °C at a rate of 25 °C/min and kept isothermal for 2 min. Helium was used as carrier gas with a flow rate of 1.491 ml/min with a split ratio of 1:10. During sample analysis, the column oven temperature was maintained at 280 °C [38].

RESULTS AND DISCUSSION:

Result:

Analysis of Phytochemicals: The Phytochemical constituents of seaweed, such as carbohydrate, protein, alkaloids, glycosides, flavonoids, tannins, phytosterols, diterpenes, resins, and saponins were analyzed and given in **Table 1**. Among the three different solvents, such as chloroform, methanol, and water used in the present study, the methanol was found to be the most suitable solvent. The extract prepared using methanol found to contain all the phytochemicals analyzed in the study except, Glycosides and Tannins. Whereas, the extracts prepared using chloroform and distilled water showed only five components out of ten analyzed. The results obtained were corroborated with the previous reports.

TABLE 1: PHYTOCHEMICAL ANALYSIS OF *C. LENTILIFERA*

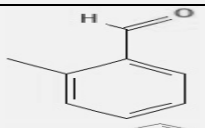
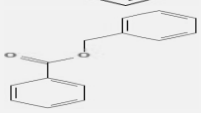
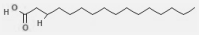
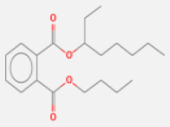
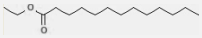
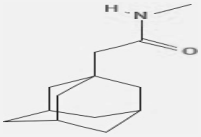
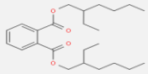
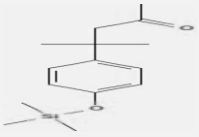
Name of Test	*Caulerpa lentilifera*		
	Chloroform	**Methanol**	**DMSO**
Test for Tannin Gelatin test	-	-	+
Test for Phytosterols Salkowski test	-	-	+
Test for Glycosides Legal's test	+	-	-
Kellar killani test	-	-	-
Test for Alkaloids Wagner's	+	-	-
Test for Carbohydrates Fehling's test- Reducing sugars	-	-	+
Benedict's test- Reducing sugars	-	+	-
Molisch's test – Non reducing sugars	+	+	-
Test for Flavonoids Alkaline reagent test	-	+	-
Test for Diterpenes Copper acetate test	-	+	-
Test for Protein Xanthoproteic test	+	+	-
Biuret test	-	-	-
Test for Resins Acetone water test	-	+	+
Test for Saponins Foam test	-	+	+
Froth test	+	-	+

GC-MS Analysis of Fatty Acid Profile: As per GC-MS analysis, in the present investigation, twelve chemical constituents have been identified from the Chloroform extract and twenty-three the methanolic extract of green alga *Caulerpa lentillifera*. The GC-MS profile of the compounds identified have indicated in **Table 2**, **3,** and **3a** and depicted in **Fig. 1** and **2**.

Determination of Antioxidant Activity:

DPPH Free Radical Scavenging Assay: DPPH has been used extensively as a free radical to evaluate reducing substances. A freshly prepared DPPH solution exhibits a deep purple color with an absorption maximum at 517 nm. This purple color generally fades/disappears when an antioxidant is present in the medium.

TABLE 2: LIST OF COMPOUNDS IDENTIFIED FROM CHROMATOGRAM OF CHLOROFORM EXTRACT OF *C. LENTILIFERA*

S. no.	Retention time	Name	Molecular formula	Molecular weight	Molecular structure	Peak area %
1	2.749 min	Benzaldehyde, 2-methyl-	C_8H_8O	120.1485		82.79%
2	9.859 min	Benzyl Benzoate	$C_6H_5CH_2O_2CC_6H_5$	212.2439		59.49%
3	11.391 min	Hexadecanoic acid, methyl ester	$C_{17}H_{34}O_2$	270.4507		83.13%
4	11.712 min	n-Hexadecanoic acid	$C_{16}H_{32}O_2$	254.422		89.79%
5	11.797 min	Phthalic acid, butyl oct-3-yl ester	$C_{20}H_{30}O_4$	334.4498		13.84%
6	12.053 min	Ethyl tridecanoate	$C_{15}H_{30}O_2$	242.3975		38.92%
7	13.187 min	Cis-9,10-Epoxyoctadecan-1-ol	$C_{18}H_{36}0_2$	284.484		94.33%
8	13.821 min	Hexadecanoic acid, 2-methylpropyl ester	$C_{20}H_{40}O_2$	312.5304		69.47%
9	13.887 min	Octadecanoic acid, ethyl ester	$C_{20}H_{40}O_2$	312.5304		41.95%
10	15.778 min	N-Methyl-1-adamantaneacetamide	$C_{13}H_{21}NO$	207.312		39.79%
11	16.837 min	Bis(2-ethylhexyl) phthalate	$C_{24}H_{38}O_4$	390.5561		26.01%
12	18.984 min	Trimethyl[4-(2-methyl-4-oxo-2-pentyl)phenoxy]silane	$C_{15}H_{24}O_2Si$	264.44		32.00%

Thus, antioxidant molecules can quench DPPH free radicals by providing hydrogen or by electron donation, conceivably *via* a free-radical attack on the DPPH molecule and convert them to a colourless/bleached product resulting in a decrease in absorbance at 517 nm. Hence, the more rapidly the absorbance decreases the more potent the antioxidant activity of the extract. The DPPH radical scavenging assay was performed with the DMSO extract of seaweed *Caulerpa lentillifera* by the well known DPPH assay and the antioxidant capacity of the *C. lentillifera* extract was validated. The findings of this experiment revealed that the highest inhibitory activity was obtained in *C. lentillifera* (79.45%). The results of the experiment showed closeness to the antioxidant activity of the

standard sample the ascorbic acid 98.93% (vitamin C) used in this study as a standard. Besides, the antioxidant activity increases with an increase in the concentrations (10, 50, 100, 250 and 500µg/ml) of seaweed extract have been noticed in the study. Apart from these, IC_{50} concentration (180.89 µg/ml) for *C. lentillifera* obtained was revealed the high efficiency of the Antioxidant activity of the seaweed **Table 4**.

Assay of Total Antioxidant Capacity: In addition to the DPPH radical scavenging activities the total antioxidant capacities of the extract were also determined with respect to Standard Ascorbic acid as a known antioxidant. The total antioxidant capacity (% of inhibition) was recorded as 75.54% and the result showed closeness to the Ascorbic acid (89.55%).

The total antioxidant capacities of the extract of *C. lentillifera* were carried out with different concentrations, such as 10, 50, 100, 250 and 500 µg/ml. The results of the experiments showed an increase in antioxidant activity with an increase in the concentration of the extract. Whereas, IC_{50} concentration of the extract of the seaweeds revealed the maximum inhibition of 212.37 µg/ml **Table 5**.

TABLE 3: LIST OF COMPOUNDS IDENTIFIED FROM CHROMATOGRAM OF METHANOLIC EXTRACT OF *C. LENTILIFERA*

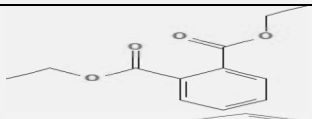
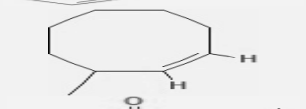
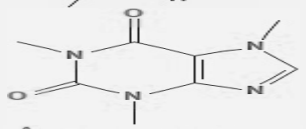
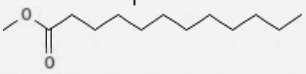
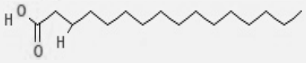
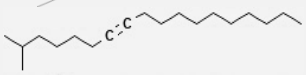
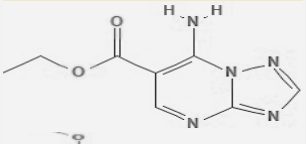
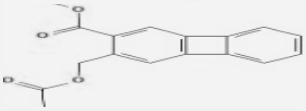
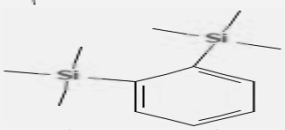
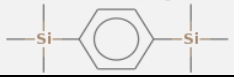
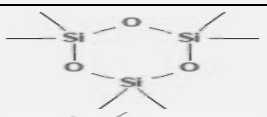
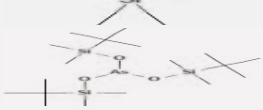
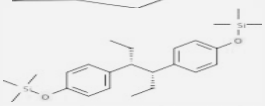
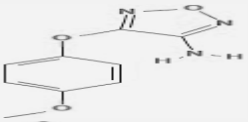
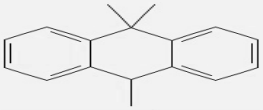
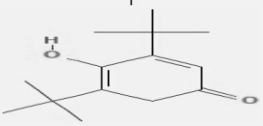
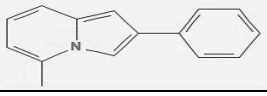
S. no.	Retention time	Name	Molecular formula	Molecular weight	Molecular structure	Peak area %
1	7.959 min	Diethyl Phthalate	$C_{12}H_{14}O_4$	222.2372		18.91%
2	9.859 min	Benzyl Benzoate	$C_{14}H_{12}O_2$	212.2439		56.27%
3	10.530 min	Cyclooctene, 3-methyl-	C_9H_{16}	124.227		93.97%
4	10.701 min	Caffeine	$C_8H_{10}N_4O_2$	194.19		66.13%
5	11.391 min	Dodecanoic acid, methyl ester	$C_{13}H_{26}O_2$	214.3443		24.70%
6	11.722 min	n-Hexadecanoic acid	$C_{16}H_{32}O_2$	254.422		72.76%
7	13.074 min	9, 12-Tetradecadien-1-ol, acetate, (Z,E)-	$C_{16}H_{28}O_2$	252.3923		80.64%
8	13.187 min	7-Octadecyne, 2-methyl-	$C_{19}H_{36}$	264.497		93.52%
9	13.395 min	Chloroacetic acid, pentadecyl ester	$C_{17}H_{33}CLO_2$	304.899		63.05%
10	15.201 min	[1, 2, 4]Triazolo[1, 5-a]pyrimidine-6-carboxylic acid, 4,7-dihydro-7-imino-, ethyl ester	$C_8H_9N_5O_2$	207.193		87.46%
11	15.334 min	2-(Acetoxymethyl)-3-(methoxycarbonyl)biphenylene	$C_{17}H_{14}O_4$	282.295		66.04%
12	16.355 min	1, 2-Bis (trimethylsilyl)benzene	$C_{12}H_{22}Si_2$	222.478		57.71%
13	16.459 min	1, 4-Bis (trimethylsilyl)benzene	$C_{12}H_{22}Si_2$	222.4741		54.92%

TABLE 3A: LIST OF COMPOUNDS IDENTIFIED FROM CHROMATOGRAM OF METHANOLIC EXTRACT OF *C. LENTILIFERA*

S. no.	Retention time	Name	Molecular formula	Molecular weight	Molecular structure	Peak area %
14	16.525 min	Cyclotrisiloxane, hexamethyl	$C_6H_{18}0_3Si_3$	222.462		37.91%
15	16.847 min	Tris(tert-butyldimethylsilyloxy)arsane	$C_{18}H_{45}ASO_3Si_3$	468.726		44.57%
16	16.988 min	N-Methyl-1-adamantaneacetamide	$C_{13}H_{21}NO$	207.317		42.31%
17	17.376 min	Hexestrol, di-TMS	$C_{24}H_{38}O_2Si_2$	414.736		43.38%
18	17.764 min	Eicosane	$C_{20}H_{42}$	282.556		73.63%
19	18.029 min	1,2,5-Oxadiazol-3-amine, 4-(4-methoxyphenoxy)-	$C_9H_9N_3O_3$	207.18606		35.09%
20	18.066 min	2,4,6-Cycloheptatrien-1-one, 3,5-bis-trimethylsilyl-	$C_{13}H_{22}OSi_2$	250.488		42.25%
21	19.608 min	Anthracene, 9,10-dihydro-9,9,10-trimethyl-	$C_{17}H_{18}$	222.331		48.68%
22	19.655 min	2,4-Cyclohexadien-1-one, 3,5-bis(1,1-dimethylethyl)-4-hydroxy-	$C_{14}H_{22}O_2$	222.328		50.73%
23	19.655 min	5-Methyl-2-phenylindolizine	$C_{15}H_{13}N$	207.276		42.60%

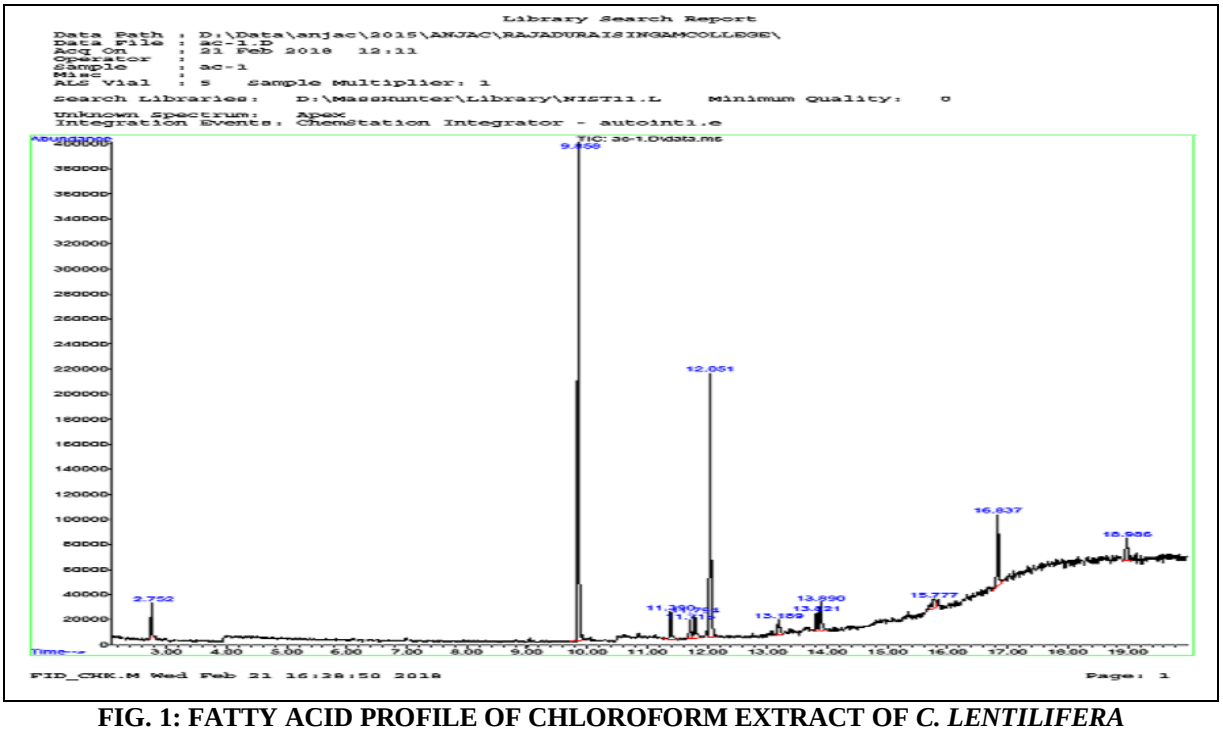


FIG. 1: FATTY ACID PROFILE OF CHLOROFORM EXTRACT OF *C. LENTILIFERA*

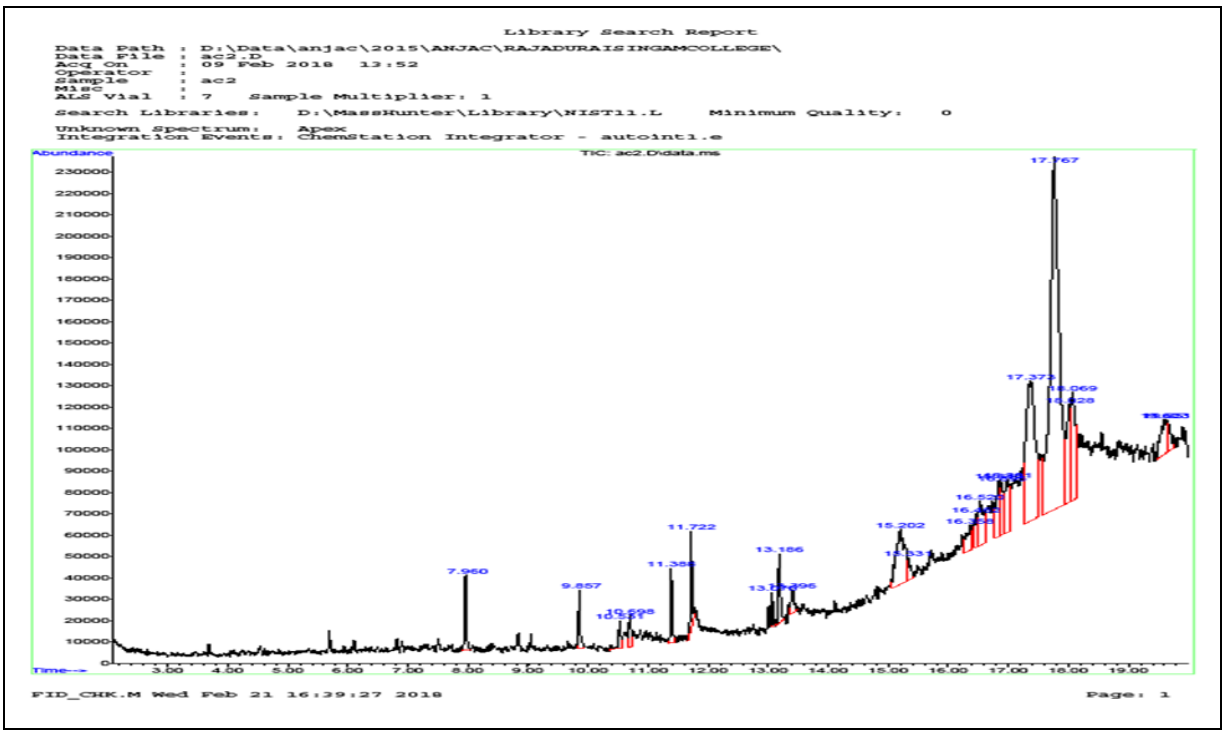


FIG. 2: FATTY ACID PROFILE OF METHANOLIC EXTRACT OF *C. LENTILIFERA*

TABLE 4: RADICAL SCAVENGING ACTIVITY OF *C. LENTILIFERA*

S. no.	Concentration µg/ml	% Inhibition		
		Caulerpa lentilifera	Standard Vitamin C	IC_{50}
1	10	14.26	22.67	
2	50	24.78	32.58	
3	100	59.67	81.11	180.89 µg/ml
4	250	72.48	88.9	
5	500	79.45	98.93	

TABLE 5: TOTAL ANTIOXIDANT ACTIVITY OF *C. LENTILIFERA*

S. no.	Concentration µg/ml	% Inhibition		
		Caulerpa lentilifera	Standard Vitamin C	IC_{50}
1	10	12.37	18.18	
2	50	20.56	29.89	
3	100	57.68	72.23	212.37 µg/ml
4	250	67.03	81.47	
5	500	74.52	89.55	

DISCUSSION:

Analysis of Phytochemicals: Algae has a wide variety of natural pigments like chlorophyll, carotenoids and phycobiliproteins, which exhibit colors ranging from green, yellow, brown and red [39-42]. The results were corroborated with the previous reports. Algae pigments have great commercial value as natural colourants in nutraceutical, cosmetics, and pharmaceutical industry as well as their health benefits [43-46].

GC-MS analysis of Fatty Acid Profile: This GC-MS analysis revealed the presence of major constituents like Benzaldehyde2-methyl, Benzyl Benzoate, Hexadecanoic acid, methyl ester, n-Hexadecanoic acid, Phthalic acid, butyl oct-3-yl ester, Ethyl tridecanoate, Cis-9, 10-Epoxyocta-decan-1-ol, Hexadecanoic acid, 2-methylpropyl ester, Diethyl Phthalate, Octadecanoic acid, ethyl ester, Chloroacetic acid, pentadecyl ester, Dodecanoic acid, methyl ester, 1, 2-Bis (tri-methylsilyl) benzene and Caffeine. Most of the identified major compounds mentioned above were generally reported to have various biological activities. Recently Benzaldehyde 2-methyl has been reported to elicit a potent antibacterial activity against cattle pathogens [47]. Likewise, the Benzyl Benzoate has anti-inflammatory activity and antiparasitic properties [48]. Hexadecanoic acid and methyl ester have antioxidant and Nematicide properties, respectively [49]. While n-Hexadecanoic acid contains Anti-oxidant, Hypocholesterolemic, Nematicide, Anti-androgenic, Hemolytic, Pesticide, Lubricant, 5-Alpha reductase inhibitor, and antipsychotic properties [50-52]. Antimicrobial activity was also reported in Phthalic acid and butyl oct-3-yl ester [53], Ethyl tridecanoate found to have the antioxidant and cytoprotective activities for tetra-tetracontane [54] and deoxyspergualin [55] respectively.

Whereas, Octadecanoic acid, ethyl ester exhibited Antimicrobial activity [56]. Dodecanoic acid and methyl ester exhibited Osteoporosis [57], Caffeine showed best synergistic activity with Mupirocin, Amoxyclav, Chloramphenicol, Rifampicin, and Linezolid antibiotics when tested against Staphylococcus aureus and MRSA [58], While, it has been reported that, Diethyl phthalate is widely used as a plasticizer and softener, pharmaceutical coatings, cosmetic additives and also as an insecticide [59]. It has been stated that, Cis-9, 10-Epoxyoctadecan-1-ol responsible for antimicrobial, analgesic, anti-inflammatory, anticancer, anti-oxidant, hepatoprotective, anti-arthritic and diuretic activities [60]. Whereas, Chloroacetic acid and Pentadecyl ester have antioxidant activity [61]. Thus, various biological activities have been reported for these phytocomponents and the results of the present investigation have indicated the pharmacological significance of *Caulerpa lentillifera*. Fatty acids derived from marine organisms have varies chemical structures that served as biological markers. It has the ability of the biological activity due to the characteristic of living environment [62].

Several studies have reported the activity of essential fatty acids from seaweed. ω-3 and ω-6 obtained from *Undaria pinnatifida* could act as anti-inflammatory and pro-inflammatory [63]. ω-3 has several functions for health, including anticancer [41] and prevent cardiovascular disease [64]. It has been reported that some seaweed has a low-fat content but high in PUFA [65]. The process of drying seaweed showed some differences in fatty acid composition [66] stated during drying some of the mechanisms that occur including decreasing of water content, lipid oxidation, diffusion, and exchange, could affect the differences in fatty acid composition.

Analysis of Antioxidant Activity: The antioxidant activity in DMSO extract by DPPH free radical assay and Total antioxidant assay were observed as concentration-dependent. Rana *et al.*, (2010) have reported a correlation between the concentration of the extract and % inhibition of free radicals in different models including DPPH radical scavenging activity. The antioxidant activity was reported in the ethanolic extract of dried *C. racemosa*. Perhaps, it was caused by a heat treatment that activated phytochemical compounds of *C. racemosa*. Heating could induce deactivation of the oxidative enzyme responsible for breaking down of antioxidant compounds [67]. Some fatty acids also could act as antioxidants. It has been suggested some of the saturated and unsaturated fatty acids have antioxidant activities [68]. The antioxidants are classified into two groups, namely the reaction breaking-antioxidant and preventive antioxidants [69-70]. MUFA and PUFA have one or more double bond, which is easily oxidized. Therefore, its ability to antioxidant activity obtained from electron donor ability, thus it could be antioxidant preventive-call as pro-oxidant.

Caulerpa lentillifera is usually eaten raw with vinegar, as a snack or in a salad. In the Philippines, after being washed in clean water, it is usually eaten raw as a salad, mixed with chopped raw shallots and fresh tomatoes. It is known to be rich in iodine. Several health benefits have been reported for *Caulerpa lentillifera* including diabetes and lipid-lowering properties.

CONCLUSION: Isolation of individual phyto-chemical constituents from *Caulerpa lentillifera* and subjecting them to meticulous biological screening can give fruitful results. From the results, it could be concluded that *Caulerpa lentilifer* contains various bioactive compounds. Therefore, it is recommended as seaweed of phyto-pharmaceutical importance. The highest anti-oxidant activity obtained from dried seaweed showed by its IC_{50} value, which is influenced by its phytochemical content and fatty acids. Therefore, fatty acids could be as antioxidants, which could also be preventive as pro-oxidant.

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