Phytochemical Analysis, Antibacterial and Antioxidant Potential of Marine Red Seaweed *Caulacanthusustulatus*

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**ABSTRACT**

Marine algae are known to produce a wide variety of bioactive secondary metabolites and several compounds have been derived from them for prospective development of novel drugs by the pharmaceutical industries. The marine red seaweed *Caulacanthusustulatus*, collected from the Kilakarai region located between (9.23135° N, 78.7844° E) Ramanathapuram District, Tamil Nadu, India. The seaweed extract was prepared from various solvent extracts namely aqueous, ethanol, methanol and acetone was tested for their phytochemical analysis, antibacterial activity against human pathogens viz., *Escherichia coli*, *Pseudomonas aeruginosa* and *Staphylococcus aureus* and aquatic pathogens viz., *Aeromonas hydrophila* and *Vibrio vulnificus* using disc diffusion methods and in vitro antioxidant activity such as DPPH radical scavenging activity, ABTS radical scavenging activity and Hydroxyl radical scavenging activity of selected solvent extracts. Phytochemical analysis of sixteen different chemical compounds was carried out. The maximum nine phytochemical compounds were present in the methanol and ethanol extracts and the minimum six compounds were present in aqueous extract. The highest antibacterial activity was present in human pathogen *P. aeruginosa* (20.66 ± 1.1mm) likewise the aquatic pathogen the antibacterial activity was increase in *Aeromonas hydrophila* (20.33 ± 1.5mm). The methanol extract was significantly higher in DPPH radical scavenging activity (67.07 ± 0.5μg/ml), ABTS radical scavenging activity (72.4 ± 0.6 μg/ml) and Hydroxyl radical scavenging activity (54.06 ± 0.58μg/ml). This study indicates the potential use of red seaweed; in particular *C. ustulatus* extracts are treating human and aquatic bacterial pathogens and it could be a potential candidate for the natural compounds as antioxidant.

**KEYWORDS:** C. *ustulatus*; Seaweed; Antibacterial; Antioxidant; DPPH; ABTS.

**Introduction**

The developments of numerous vaccines, usually against human and fish pathogens, and the use of diverse antimicrobial agents have reduced the impact of several infective diseases. However, at present, an increasing demand for more environment-friendly infection control schemes and many researchers have looked at alternate approaches. Among these approaches, the use of abundant natural products that derive from different living organisms, such as plants, animals, and marine organisms had acknowledged a percentage of attention process displays potential novel bioactive material (Metzger et al., 2002).

Seaweeds incorporate numerous natural and inorganic materials that can benefit human health (Kuda et al., 2002; Kokilam and Vasuki, 2014). Seaweeds are capability resources of bioactive compounds and additionally play a vital role within the economy of different countries as a source of food, fodder, fertilizers, chemical compounds, drugs and numerous different commercial algal merchandise together with agar-agar, algin and carrageenan and giant pharmaceutical, biomedical and nutraceutical importance. They are taken into consideration as low calories foods with excessive content of minerals, vitamins, proteins and carbohydrates, rich in fiber and with relatively high concentrations of polysaturated fatty acids and extraordinary antioxidants (Risso et al., 2003; Veena et al., 2006; Cardozo et al., 2007; Erulan et al., 2011; Valentina et al., 2015; Nithya and Dhanalakshmi, 2016).

Algae are exposed to big amounts of light and high concentrations of oxygen; this combination favours the generation of free radicals, as well as other effective oxidizers it is suggested that the absence of oxidative damage in the structural components of the algae and their stability against adverse conditions are because of the presence of antioxidants. It has been reported that algae generally exhibit higher antioxidant activity due to the presence of non-enzymatic antioxidant compounds (Gupta and Abu-Ghannam, 2011; Samarakoon and Jeon, 2012). Numerous reports consider macroalgae to be a rich source of antioxidants and their extracts had been studied to produce a variety of compounds and some of
them have even reported possessing bioactivity of ability to medicinal value (Athukorala et al., 2003).

Hence, the search for novel bioactive substances from natural sources is very important and seaweeds are this sort of useful resource with immense potential, waiting to be tapped substantially for the gain of mankind. When you consider that historical instances, marine seaweed extracts have been used for treatments of common infectious diseases; treatments with plants having antibacterial activity are a potentially useful alternative in aquaculture (Abutbul et al., 2005). Numerous works were undertaken on crude and purified compounds received from seaweeds for evaluating their bioactive potential (Gupta et al., 2010).

Therefore, the aim of the present study was to examine the antibacterial activity of extracts from marine algae against human and aquatic pathogenic bacterium that are often the cause of bacterial diseases in human and aquaculture. The present study was undertaken to evaluate the extract of red seaweed Caulacanthus ustulatus using various solvents like aqueous, ethanol, methanol and acetone. Herein we report the phytochemicals were present in the C. ustulatus, in vitro antioxidant activity of 1, 1-Diphenyl-2-picrylhydrazyl (DPPH) and 2, 2′-azino-bis (3-ethylbenzthiazoline)-6-sulfonic (ABTS), and their antibacterial efficacy of human and fish pathogens.

Materials and Methods

Collection of Sample

Seaweed samples were collected from Kilakarai coast (9.2343° N, 78.7836° E), Ramanathapuram, Tamil Nadu, India. The collected samples were cleaned well with seawater to remove the extraneous matters such as epiphytes, sand particles, pebbles, and shells brought to the laboratory in sterile bags. The samples were then washed thoroughly with tap water and distilled water and spread in dark at room temperature for drying. Seaweeds were identified at Central Marine Fisheries Research Institute (CMFRI), Tuticorin, Tamil Nadu, India.

Sample preparation

Dried seaweeds were ground using mixer without producing heat and converted to powder. The powder sample was stored in room temperature for further use.

Extraction method

25 grams of powdered seaweed was successfully extracted with aqueous, ethanol, methanol and acetone as solvents. Container containing seaweed powder was immersed in the solvent and the extract was collected using Soxhlet apparatus. Fractions were completely dried by evaporation at room temperature and stored in sterile container in refrigerator for further use.

Phytochemical analysis

The extracts from different solvents were tested for Steroids, Tannins, Terpenoids, Flavonoids, Saponins, Alkaloids, Reducing sugar, Cardiac glycosides, Coumarins, Phlobatannins, Anthraquinones, Quinones, Glycosides, Phenols, Anthocyanin, Betacyanin. Phytochemical analysis of the extract was carried out according to the standard methods (Harborne, 1973; Sadasivam and Manickam, 1996).

Antibacterial activity

Test microbes

The human pathogenic bacterial strains are Escherichia coli (MTCC 2939), Pseudomonas aeruginosa (MTCC 2453) and Staphylococcus aureus (MTCC 9706) and aquatic pathogens, Aeromonas hydrophila (MTCC 1739) and Vibrio vulnificus (MTCC 1146) were used for this experiment. The pathogens were obtained from Microbial Type Culture Collection (MTCC), Institute of Microbial Technology (IMTEC), Chandigarh, India. It was sub cultured and used for the antibacterial assay.

Disc diffusion method

The antibacterial activity of seaweed extracts was assessed by the disc diffusion technique (Ramesh kumar and Sivasaduha, 2012). Mueller Hinton agar (MHA) plates were prepared and individually swabbed with pathogenic bacteria. The sterile discs (6 mm) were placed over the surface of the agar plates. Preparation of seaweed extract (1 mg/mL) was added on the discs at various concentrations (50, 100, 250 and 500 µg/mL). A disc containing standard concentrations of the antibiotic Ciprofloxacin (20 µg/disc) was used as positive control. The agar plates were incubated for 24 h at 37°C and the inhibition zones were measured in millimeter and the experiment was repeated thrice for concordant results. All the data were statistically analyzed.

Minimum Inhibitory Concentration (MIC)

The minimum inhibitory concentration was carried out according to the methods of National Committee for Clinical Laboratory Standards (NCCLS). The seaweed extracts were selected for the solvents aqueous, ethanol, methanol and acetone. The initial test concentration of extract was 1 mg/mL. Each tube containing 2 mL of broth was inoculated with 5µL of bacterial suspension containing 10⁶ CFU/mL of bacteria. Ciprofloxacin was used as positive control. The test tubes were incubated for 24 h at 37°C. MIC was determined as the lowest concentration of extract showing OD of 600nm of spectrophotometer. All the data were statistically analyzed.

In vitro antioxidant activity

1, 1-Diphenyl-2-picrylhydrazyl (DPPH) radical scavenging activity

1, 1-Diphenyl-2-picrylhydrazyl (DPPH) radical scavenging activity was estimated using the method of Lianai-Pathirana and Shahidi, (2005). Appropriate dilutions of the extract (1 mg/mL) was mixed with, 1 mL of 0.135 mM methanolic solution of DPPH radical. Absorbance was measured at 517 nm after 30 min of reaction. BHT was
used as reference standard and the inhibition percentage was calculated using the following formula:

\[
\text{Percentage of inhibition} = \left[ \frac{\text{Abs}_{\text{control}} - \text{Abs}_{\text{sample}}}{\text{Abs}_{\text{control}}} \right] \times 100
\]

2. 2-azino-(3-ethylbenzthiazoline)-6-sulfonic (ABTS\(^+\)) radical scavenging activity

Determination of 2, 2’-azino-bis-(3-ethyl-benzthiazoline)-6-sulfonic (ABTS\(^+\)) radical scavenging ability of seaweed extracts was carried out by the method of Re et al. (1999). Previously, 7 mM ABTS solution and 2.4 mM potassium persulfate solution were prepared separately. Equal amount of two stock solutions were mixed and allowed to stand for 12 h in dark at room temperature. About 1 mL of diluted ABTS\(^+\) solution react with plant extract (1mg/mL) after 10 min the absorbance was measured UV-spectrophotometrically at 734 nm against the blank solution. ABTS free radical inhibition was calculated by following

\[
\text{Percentage of inhibition} = \left[ \frac{\text{Abs}_{\text{control}} - \text{Abs}_{\text{sample}}}{\text{Abs}_{\text{control}}} \right] \times 100
\]

Hydroxyl radical scavenging activity

Hydroxyl radical scavenging activity was determined according to a slightly modified method of the 2-deoxyribose oxidation methods (Chung et al., 1997). Hydroxyl radical was generated by Fenton reaction in the presence of FeSO\(_4\).7H\(_2\)O. A reaction mixture containing 0.2 mL each of 10 mM FeSO\(_4\).7H\(_2\)O, 10 mM EDTA and 10 mM 2-deoxyribose was mixed with 0.2 mL of the extract solution, and 0.1 M phosphate buffer (pH 7.4) was added into the reaction mixture until the total volume reached 1.8 mL. Then 0.2 mL of 10 mM H\(_2\)O\(_2\) was finally added to the reaction mixture and incubated at 37° C for 4 h. After the incubation 1 mL of 2.8% TCA (trichloracetic acid) and 1.0% TBA (thiobarbituric acid) were added. Then, the mixture was placed in a boiling water bath for 10 min. Absorbance was measured at 532 nm.

% Radical scavenging activity = \left[ \frac{\text{Abs}_{\text{control}} - \text{Abs}_{\text{sample}}}{\text{Abs}_{\text{control}}} \right] \times 100

Statistical Analysis

All the values were expressed as Mean ± Standard Deviation (SD). The statistical significance was evaluated by two-way Analysis of Variance (ANOVA) using SPSS version 20 (SPSS, Cary, NC, USA) and the individual comparisons were obtained by Post-hoc analysis, Duncan (Zar, 2007).

Results

Phytochemical analysis of Caulacanthus ustulatus

The phytochemical investigation of seaweed C. ustulatus (Table 1) of the different solvent extracts was analyzed. Out of fifteen different tests of C.ustulatus, aqueous extract contains six compounds, ethanol extract contains nine compounds, methanol extract contains nine compounds and acetone extract contains seven compounds. The compound phenols present in all solvent extracts.
### TABLE 2
Antibacterial activity of seaweed extracts of *Caulacanthus ustulatus* against human pathogens (Mean ± SD, n = 3).

<table>
<thead>
<tr>
<th>Solvents</th>
<th>Concentration (µg/mL)</th>
<th>Zone of Inhibition (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><em>E. coli</em></td>
</tr>
<tr>
<td>Aqueous</td>
<td>50</td>
<td>6 ± 0.0</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>7.66 ± 1.1</td>
</tr>
<tr>
<td></td>
<td>250</td>
<td>8.00 ± 1.0</td>
</tr>
<tr>
<td></td>
<td>500</td>
<td>10.33 ± 1.1</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>20.66 ± 0.5</td>
</tr>
<tr>
<td>Ethanol</td>
<td>50</td>
<td>10.00 ± 1.0</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>11.66 ± 2.0</td>
</tr>
<tr>
<td></td>
<td>250</td>
<td>13.33 ± 1.5</td>
</tr>
<tr>
<td></td>
<td>500</td>
<td>17.00 ± 1.7</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>21.33 ± 1.5</td>
</tr>
<tr>
<td>Methanol</td>
<td>50</td>
<td>8.66 ± 0.5</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>13.00 ± 1.1</td>
</tr>
<tr>
<td></td>
<td>250</td>
<td>17.00 ± 1.0</td>
</tr>
<tr>
<td></td>
<td>500</td>
<td>20.00 ± 1.0</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>23.00 ± 1.0</td>
</tr>
</tbody>
</table>

*C: Ciprofloxacin, ANOVA (P<0.05)*

### TABLE 3
Antibacterial activity of seaweed extracts of *Caulacanthus ustulatus* against aquatic pathogens (Mean ± SD, n = 3).

<table>
<thead>
<tr>
<th>Solvents</th>
<th>Concentration (µg/mL)</th>
<th>Zone of Inhibition (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><em>A. hydrophila</em></td>
</tr>
<tr>
<td>Aqueous</td>
<td>50</td>
<td>9.00 ± 1.0</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>13.66 ± 1.5</td>
</tr>
<tr>
<td></td>
<td>250</td>
<td>14.66 ± 0.5</td>
</tr>
<tr>
<td></td>
<td>500</td>
<td>14.33 ± 2.0</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>20.66 ± 1.1</td>
</tr>
<tr>
<td>Ethanol</td>
<td>50</td>
<td>8.66 ± 1.1</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>13.00 ± 1.7</td>
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<td>16.66 ± 1.1</td>
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<td>500</td>
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<tr>
<td></td>
<td>C</td>
<td>24.66 ± 1.5</td>
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<tr>
<td>Methanol</td>
<td>50</td>
<td>7.33 ± 0.5</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>13.33 ± 1.1</td>
</tr>
<tr>
<td></td>
<td>250</td>
<td>14.33 ± 0.5</td>
</tr>
<tr>
<td></td>
<td>500</td>
<td>17.33 ± 1.5</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>22.00 ± 3.0</td>
</tr>
<tr>
<td>Acetone</td>
<td>50</td>
<td>6 ± 0.0</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>10.33 ± 0.5</td>
</tr>
<tr>
<td></td>
<td>250</td>
<td>15.33 ± 0.5</td>
</tr>
<tr>
<td></td>
<td>500</td>
<td>18.33 ± 0.5</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>21.00 ± 1.0</td>
</tr>
</tbody>
</table>

*C: Ciprofloxacin, ANOVA (P<0.05)*

### TABLE 4
MIC of *Caulacanthus ustulatus* extracts against the human and aquatic pathogens.

<table>
<thead>
<tr>
<th>Bacterial species</th>
<th>Solvents</th>
<th>Aqueous</th>
<th>% of Inhibition</th>
<th>Ethanol</th>
<th>% of Inhibition</th>
<th>Methanol</th>
<th>% of Inhibition</th>
<th>Acetone</th>
<th>% of Inhibition</th>
<th>Ciprofloxacin % of Inhibition</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>E. coli</em></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>93.20</td>
</tr>
<tr>
<td>500</td>
<td>43.54</td>
<td>40</td>
<td>61.05</td>
<td>100</td>
<td>52.60</td>
<td>50</td>
<td>61.53</td>
<td>100</td>
<td>52.12</td>
<td></td>
</tr>
<tr>
<td>400</td>
<td>42.65</td>
<td>80</td>
<td>50.61</td>
<td>80</td>
<td>52.12</td>
<td>40</td>
<td>52.12</td>
<td>30</td>
<td>49.51</td>
<td></td>
</tr>
<tr>
<td>300</td>
<td>42.17</td>
<td>60</td>
<td>44.84</td>
<td>60</td>
<td>49.51</td>
<td>30</td>
<td>49.51</td>
<td>30</td>
<td>47.11</td>
<td></td>
</tr>
<tr>
<td>200</td>
<td>41.00</td>
<td>40</td>
<td>42.10</td>
<td>40</td>
<td>47.87</td>
<td>20</td>
<td>47.11</td>
<td>20</td>
<td>39.56</td>
<td></td>
</tr>
<tr>
<td>100</td>
<td>38.59</td>
<td>20</td>
<td>41.41</td>
<td>20</td>
<td>47.80</td>
<td>10</td>
<td>39.56</td>
<td>10</td>
<td>39.56</td>
<td></td>
</tr>
</tbody>
</table>

*TABLE 4 Contd...*
In vitro antioxidant Activity

1,1-Diphenyl-2-picrylhydrazyl (DPPH) radical scavenging activity

The DPPH radical scavenging activity of *C. ustulatus* extracts and the synthetic antioxidant (BHT) compounds are shown in Figure 1. The ability of seaweed extracts to scavenge the reactive metabolites would inhibit the formation of primary and secondary amines oxidation products. In this analysis, *C. ustulatus* showed highest DPPH free radical scavenging activity of all extracts increased as the concentration increased (P < 0.05). However, significantly higher activity in methanol extract (67.07±0.5%) followed by ethanol (66.16±0.3 %), acetone (55.39±1.1%) and aqueous extract (54.1.4±0.8%) when compared than that of BHT (73.12±6.2).

![Fig. 1. 1,1-Diphenyl-2-picrylhydrazyl (DPPH) radical scavenging activity of *C. Ustulatus* (Mean ± SD, n = 3).](image)

2,2-azino-bis (3-ethylbenzthiazoline)-6-sulfonic (ABTS+) radical scavenging activity

ABTS+ radical scavenging activities of the extracts of *C. ustulatus* compared with BHT showed 20-100 μg/mL concentration (Figure 2). ABTS+ radical scavenging activity of all extracts increased as the concentration increased (P < 0.05). It was observed that the methanol extract showed higher activity than ethanol, acetone and aqueous extracts. The percentage inhibition of ABTS+ radicals by methanol extract reached up to 72.4±1.0 % at the concentration of 100 mg/mL, whereas the ethanol, acetone and aqueous extract showed 68.65 %, 69.3 % and 53.84 % at the same concentration respectively.

![Fig. 2. 2,2-azino-bis (3-ethylbenzthiazoline)-6-sulfonic (ABTS), radical scavenging activity of *C. Ustulatus* (Mean ± SD, n = 3).](image)

Hydroxyl Radical Scavenging Activity

Hydroxyl radical scavenging activity of the various solvent extracts from seaweed *C. ustulatus* against hydroxyl radical was investigated using Fenton reaction (Fe²⁺ + H₂O₂ → Fe³⁺ + OH⁻ + OH) and these outcomes were expressed as the inhibition rate. Hydroxyl radical scavenging activity levels of the various extracts are shown in Figure 3 and these activities were compared to that of BHT. The scavenging activity of the various solvent extracts ranged by (14.63-54.06 %) and higher level of inhibitory radical scavenging activity was observed with BHT (10.79-64.7 %). Among seaweed extracts, higher level of hydroxyl radical scavenging activity was recorded in methanol extract (54.06±0.58 %) followed by ethanol extract (52.61±0.53 %), acetone extract (50.55±0.5 %) and aqueous extract (48.48±0.6 %).
acetone, ethyl alcohol and ether showed higher hydroxyl radical scavenging activity. Thirumaran and Anantharaman, (2006) screened the antimicrobial activity of *H. clathratus* using methanol extracts and reported that *P. aeruginosa* were more susceptible than the other extracts. The similar result was observed in this study; the strongest antibacterial activity was exhibited by the methanol extract and the least by aqueous. In our study it was reported that the methanol extracts of *C. ustulatus* showed highest antibacterial activity against *P. aeruginosa* (20.66±1.1 mm) when compared to other solvents which were studied.

Several works were reported for broad-spectrum antibacterial activity of seaweed extracts was centered. Different extracts of seaweeds have been inspected for antibacterial activity towards pathogens in humans, agriculture and fish. Extracts of seaweeds, *Sargassum wightii, Gracilaria crassa, Acanthophora spicifera, Turbinaria conoides, Caulerpa scalpelliformis,* and *Codium decorticatum* from Gulf of Mannar exhibited antibacterial activity contrary to *Vibrio parahaemolyticus,* *Escherichia coli,* *Klebsiella pneumoniae,* *Streptococcus pyogenes,* *Shewanella sp,* *Salmonella sp,* *Staphylococcus aureus,* *Pseudomonas aeruginosa* *Enterococcus faecalis* and *Proteus mirabilis* (Lavanya and Veerappan, 2011; Ganeshamurthy et al., 2012; Saritha et al., 2013).

Several synthetic antioxidants have shown the toxic effect and mutagenic effects, which have shifted thought toward naturally occurring antioxidants. A great number of naturally occurring substances like seaweeds have been recognized to have antioxidant abilities. Seaweeds are considered as a major food ingredient in Asian countries (Jimenez-Escrig and Sanchez-Muniz, 2000). Naturally seaweeds are contains novel antioxidant compounds which control the free radical formation from metabolic reaction. Recent years, it has drawn attention of many researchers worldwide due to the rich source of antioxidant compounds (Alekseyenko et al., 2007).

In the present study, the antioxidant of the various solvents like aqueous, ethanol, methanol, and acetone extracts of seaweed *C. ustulatus* was estimated through in vitro antioxidant activity than that of extracts obtained with chloroform. Thirumaran and Anantharaman, (2006) screened the antimicrobial activity of *H. clathratus* using methanol extracts and reported that *P. aeruginosa* were more susceptible than the other extracts. The similar result was observed in this study; the strongest antibacterial activity was exhibited by the methanol extract and the least by aqueous. In our study it was reported that the methanol extracts of *C. ustulatus* showed highest antibacterial activity against *P. aeruginosa* (20.66±1.1 mm) when compared to other solvents which were studied.

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In the present study, the antioxidant of the various solvents like aqueous, ethanol, methanol, and acetone extracts of seaweed *C. ustulatus* was estimated through in vitro antioxidant activity than that of extracts obtained with chloroform. Thirumaran and Anantharaman, (2006) screened the antimicrobial activity of *H. clathratus* using methanol extracts and reported that *P. aeruginosa* were more susceptible than the other extracts. The similar result was observed in this study; the strongest antibacterial activity was exhibited by the methanol extract and the least by aqueous. In our study it was reported that the methanol extracts of *C. ustulatus* showed highest antibacterial activity against *P. aeruginosa* (20.66±1.1 mm) when compared to other solvents which were studied.
J. rubens had the highest DPPH free radical scavenging activity. Many species of seaweed possess scavenging ability for hydrogen peroxide (Athukorala et al., 2003; Sriwardhana et al., 2003). The previous reports in the literature of the antioxidant ability of algae, alcholic and aqueous extracts of seaweeds have been evaluated for DPPH activity (Gulcin, 2006; Jimenez-Excrig et al., 2012). Devi et al. (2008) mentioned that DPPH radical scavenging ability differed very much and their variety between 5% and 72.5% for C. hornemanni and G. acerosa, respectively. Heo et al. (2006) reported that Gracilaria verrucosa and Polysiphonia japonica methanolic extract of exhibit the best performance showing a high scavenging activity.

In the present investigation of ABTS assay has been widely used to investigate free radical scavenging activity of various extracts. ABTS+ scavenging activities of the aqueous extract (53.84 %), ethanol extract (68.65 %), methanol extract (72.4 %) and acetone (69.3 %) extracts of the seaweed C. ustulatus was (Figure 2) smaller than the activity of BHT (75.71 %). The high level of ABTS+ scavenging activity found out by methanol extract (72.4 %) extract of C. ustulatus can be due to the presence of carotenes/other pigments with long hydrocarbon chain and aminated compounds (Chew et al., 2008; Chakraborty et al., 2015). In fact, the mechanism of antioxidant action of those ethanol fractions can provide an explanation for as its H-donating property, thereby terminating the oxidation process by converting free radicals to the stable forms. Previously reported that methanol fraction of A. acetabulums registered significantly higher ABTS+ scavenging activity (92 %) (Sivaramakrishnan et al., 2017).

Hydroxyl radical scavenging activity was working to understand the potential of numerous seaweed extract/fractions against short-lived radicals, viz. HO-radical that abstract H atoms which causes peroxide response of lipids membranes, and hence bring about peroxide reactions of lipids. The HO scavenging activities of brown seaweeds were suggested to be due to polyphenolic compounds which include phlorotannins which could act as electron traps and are responsible for the multifunctional antioxidant properties along with scavenging of hydroxyl radicals, peroxy radicals or superoxides (Gupta and Abu-Ghannam, 2011). Ascorbic acid is also reported to be the precept component liable for HO scavenging activities in brown seaweeds (Abe et al., 1992). There also are previous reports which show those seaweed fractions are potential HO scavengers (Cho et al., 2011). The present study indicates at imply the novel radical scavenging activities of the various solvent extracts of aqueous extract (48.48 %), ethanol extract (52.61 %), methanol extract (54.06 %) and acetone extract (50.55 %) turned into decrease than the activity of BHT (64.7%). The high level of Hydroxyl radical scavenging activity was found in methanol extract (54.06 %) of C. ustulatus. Chakraborty et al. (2015) previously investigate to HO scavenging activity of methanol extract of J. rubens, seaweeds registered significantly enhanced HO radical scavenging activity. The present study correlates well with earlier studies that about 90% HO scavenging activity was reported from Dichloromethane and Butanol fractions of red seaweeds Acanthophora spicifera and Gracilaria edulis (Ganesan et al., 2008). The extracts of red seaweeds, Gracilaria verrucosa, Gracilaria textori, Grateloupia filicina and Polysiphonia japonica also reported potentially high HO scavenging activity (Heo et al., 2005).

Conclusions
The ability of different solvent extracts of C. ustulatus to produce bioactive compounds of potential therapeutic interest. The production of antibacterial activities was considered to be an indicator for the capability of the seaweeds to synthesize bioactive compounds. Marine natural products contain a wide range of novel bioactive compounds or antibiotics.

Declaration of interest:
The authors report no conflicts of interest.

Reference


