PHARMACOGNOSY
CHAPTER V
PHARMACOGNOSTIC STUDIES

5.1 INTRODUCTION

Pharmacognosy means entire knowledge of drugs. Seydler, a German scientist, coined the term “Pharmacognosy” in 1815 in the title of his work “Analecta Pharmacognostica” . According to Bruneton , ‘Pharmacognosy’ is an applied science that deals with the biological, biochemical and economic features of natural drugs and their constituents. The most comprehensive idea of the scope of pharmacognosy was presented by Pluckiger . According to him it is the simultaneous application of various scientific disciplines with the object of acquiring knowledge of drug from every point of view. It is the scientific study of the structural, physical, chemical and sensory characters of crude drugs of animal, vegetable and mineral origin. Pharmacognosy also includes their history, cultivation, collection and other particulars relating to the treatment they receive during their passage from the producer to the distributor or pharmacist. Pharmacognosy plays an important role as liaison agent between pharmacology and pharmaceutical chemistry on one hand, and pharmacy and pharmacy administration on the other. The microscopic examination of different parts of the drug provides several diagnostic characters.
5.2 MATERIALS AND METHODS

5.2.1 Collection of Specimens

The plant specimens for the proposed study were collected along the Tuticorin coast at Hare Island, near Green Gate and Red Gate areas. Care was taken to select healthy plants. The algal species included are Caulerpa scalpelliformis (R.Brown ex Turner) G.Agardh and Ulva lactuca L. belonging to Chlorophyceae (Green algae); Padina tetrastromatica Hauck and Stoechospermum marginatum (C. Agardh) Kutzing, belonging to Phaeophyceae (Brown algae); and Acanthophora spicifera (Vahl) Boerg, belonging to Rhodophyceae (Red algae).

5.2.2 Processing of Seaweed Samples

For anatomical studies, different organ samples from selected algal specimens were removed and fixed in FAA (Formalin-5ml + Acetic acid-5ml + 70% Ethyl alcohol-90ml). The specimens were left in the preservative for two days. Then the materials were washed in water, cut into small pieces and used. For physiochemical analysis, the collected samples were cleaned well with sea water to remove all the extraneous matter such as epiphytes, sand particles, pebbles and shells and brought to the laboratory in plastic bags. The samples were thoroughly washed in fresh water, blotted and weighed. They were shade dried, powdered, sieved and used for analysis.
5.2.3 Anatomical Studies

5.2.3 (a) Dehydration and Infiltration

Dehydration of the specimen was carried out by employing graded series of t-butyl alcohol (TBA)\(^4\). After total dehydration, infiltration of the specimen was carried out by gradual addition of paraffin wax (melting point 58-60\(^0\) C) until TBA solution attained super saturation.

5.2.3 (b) Sectioning and Staining

For anatomical investigation paraffin embedded specimens were sectioned by following standard microtome techniques \(^5\). The sections of 10-12 \(\mu m\) thickness were stained \(^6\) with Toluidine Blue at pH 4.

5.2.3 (c) Photographing

Sections were photographed in different magnifications with Nikon Labphot 2 Microscopic Unit. For normal observations, bright field was used and polarized light was used for the study of crystals, starch grains and lignified cells. The standard descriptive terms \(^7\) are given for the anatomical features.

5.2.4 Physiochemical Analysis

5.2.4 (a) Fluorescence Analysis

The powders of the plant materials under investigation and their extracts in various solvents were examined under ordinary light and in UV light (254nm and 365nm). These powders were also treated with various chemical reagents like aqueous 1N Sodium hydroxide, alcoholic 1N Sodium hydroxide, 1N Hydrochloric
acid, 50% Sulphuric acid and 50% Nitric acid and the changes in color were recorded.

5.2.4 (b) Determination of Moisture Content

Fresh samples were used for the determination of moisture content. Drying is the method employed for the estimation of the moisture content. The samples were blotted well; 2g of the sample was spread uniformly in the dish and dried in the oven at 100 ± 2°C for about 16 hours. It was cooled in a desiccator and the loss in weight was recorded as moisture.

5.2.4 (c) Determination of Total Ash Content

2g of the shade dried crude algal sample was taken in a pre-cleaned, pre-weighed silica crucible and maintained in a muffle furnace at 600°C for 6 hours. The crucible was then taken out and cooled to room temperature and weighed. The percentage of ash obtained was calculated with reference to the air-dried sample.

5.2.4 (d) Determination of Acid-insoluble Ash

About 0.1g of ash was boiled with 25ml of dilute hydrochloric acid (2N), the insoluble matter was collected in a previously weighed sintered crucible, washed with hot water, dried to constant weight, and weighed. The percentage of acid-insoluble ash was calculated with reference to the air-dried sample.

5.2.4 (e) Determination of Sulphated Ash

2g of the shade dried crude algal sample was moistened with Sulphuric acid, ignited gently, moistened again with Sulphuric acid, reignited, cooled and weighed.
The percentage of sulphated ash was calculated with reference to the air-dried sample.

5.2.4(f) Determination of Extractive Values

The extractive values were determined as per standard procedures \(^9\). About 5g of the air-dried sample was taken in a stoppered flask. 100 ml of the solvent was added, shaken well, and allowed to stand still for 24 hours with occasional shaking. The content was filtered and 50ml of the filtrate was pipetted out into a clean, previously weighed china dish. It was evaporated on a water bath, dried at 105°C, cooled, and weighed. The percentage of solvent soluble extractive values with reference to the air-dried sample was calculated. Different solvents namely, petroleum ether, benzene, chloroform, methanol and water were used to assess the extractive values.

RESULTS AND DISCUSSION

*Caulerpa scalpelliformis* showed some specific characteristic macroscopic features\(^{10}\). It is somewhat yellowish green in color (Fig.5.1). Plants adhere well to drying. There is a well developed cylindrical stolon, about 1mm thick, sending out rhizoids from lower surface and assimilators from the upper surface. Several assimilators with or without pedicels are arising from the horizontal stolon. They are flat, linear, lanceolate, 10-12cm in length and upto 1cm broad at the broadest part. The pinnate ramuli are up-curved, quiet flat, opposite, more or less having the same width at base and middle part. Each ramulus is 5mm long, and 1-
15 mm broad. Apex of ramulus is rounded or mucronate. Proliferations arise from
the assimilators; continue to grow to form fresh assimilators.

*Ulva lactuca* is macroscopic and bright yellowish green in color (Fig.5.2). It appears
as a large sheet and has a small disc like leaf with undulating wide blade.
The blade is 20cm tall, heart or oval shaped and occasionally with some holes.

The brown alga *Padina tetrastromatica* is fan shaped (Fig.5.3), 6-15cm in
height and 5-12cm in breadth. The thallus is repeatedly branched. It has many
overlapping circular or semicircular lobes and has many coaxial, dark zones of
varying breadth. The outer margin of the thallus is revolute and rolled two or three
times. The apical portion of the thallus is composed of an upper layer and a lower
layer. The upper layer is made up of rectangular thin walled cells. The plant body
is attached to the substratum by means of thick, flat, dark rhizome which produces
dense hairy rhizoidal outgrowths for attachment. The brown alga, *Stoechospermum
marginatum* is yellowish brown, flat, fairly thick and dichotomously branched.
Each branch is notched at the apex (Fig.5.4).

The red alga, *Acanthophora spicifera* is dark-purple in color (Fig.5.5). It is a bushy erect plant and 15 to 20cm tall. It is attached to the substratum by a
small disc like holdfast. It has cylindrical branches and slim surface. The terminal
parts of the branches are tapering and coiled like watch-spring, the branching is
irregular and profuse.

In cross-sectional view, the assimilator of *Caulerpa scalpelliformis* is
320\(\mu\)m thick in the middle. It consists of a thin single layered epidermis and a
central part, which is traversed by reticulate filamentous trabeculae (Figs. 5.1.1, 5.1.2 and 5.1.3) the margin is semicircular, with slightly thick epidermal layer and is 150\(\mu\)m thick (Fig.5.1.3). The solid rhizome in T.S. shows irregular lobes and furrows. It has a thick cuticle and is filled with mucilage and trabeculae (Figs.5.1.4, 5.1.5, 5.1.6 and 5.1.7).

In cross-sectional view, the thallus of *Ulva lactuca* is even, smooth, and occasionally bears raised cysts on the surface. The thallus is 150\(\mu\)m thick, surrounded by epidermal layers on both the surfaces and they are darkly stained. It has a two layered wide rectangular medullary cells. The thallus is dilated at certain place. Horizontally running tubular cells are seen at the centre (Figs. 5.2.1, 5.2.2, 5.2.3 and 5.2.4).

The thallus of *Padina tetrastromatica* in cross section is 50\(\mu\)m thick in the middle part and 10 \(\mu\)m thick along rolled margin (Fig.5.3.1). It is two cells thick in the middle portion. Both the layers have broad, rectangular and thick walled cells with dark contents (Fig.5.3.2). The fertile regions of the thallus have dark bands. This part of the thallus is three or four layered and 170\(\mu\)m thick. Tetrasporangia, the asexual reproductive structures are seen in transverse rows on one side of the thallus. They are spherical, sessile, thick walled and compactly arranged. A matured tetrasporangium has four tetra spores (Figs.5.3.3 and 5.3.4).

The rhizoidal part of the thallus of *Padina tetrastromatica* is 40\(\mu\)m thick and is flat. It consists of two epidermal layers. The cells of epidermis are small, squarish and with thick cuticle. There are two layers of large, vertically rectangular compact
cells found in between the epidermal layers. A dense mat of unicellular, long, thin threads of mycelial outgrowths are produced from the epidermal cells (Figs. 5.3.5 and 5.3.6).

The thallus of *Stoechospermum marginatum* is 320µm thick in T.S., flat and isobilateral. The surfaces are smooth and even. The epidermal layers are distinct and cutinized. The epidermal cells are small, squarish, thick-walled and darkly stained. There are about 8 or 9 layers of homogeneous, compact parenchyma cells found in between the epidermal layers (Fig. 5.4.1)

The basal stalk portion of the thallus has wider epidermal layers with vertically elongated cells. In between the epidermal layers, there are about 5 layers of large, horizontally elongated cells with undulate walls. The marginal part of the stalk is slightly thick and round (Figs. 5.4.2 and 5.4.3).

At certain regions, the thallus has some raised, hemispherical sporangial bodies. The sporangia are deeply sunken in the ground tissue with a thin covering. Each sporangium has many elongated, cylindrical spores. The spores have echinate surface and are staining darkly (Fig. 5.4.4).

The thallus of *Acanthophora spicifera* is circular in C.S., with deep, irregular lobes (Fig. 5.5.1). It is surrounded by a thick epidermal layer which has a prominent mucilaginous surface coating. Inner to the epidermis is the single layered cortex with large cells. The epidermal cells in surface view are polygonal in outline, thin walled and compact (Fig. 5.5.2). The central part is the medulla, which consists of

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dilated, large and lobed cells (Figs. 5.5 3 and 5.5.4). No specific inclusions are evident in the cells.

Many phytodrugs, when suitably illuminated, emit light of a different wavelength or color. This fluorescence ceases when the existing light is removed and, the fluorescence light is always of greater wavelength. In fluorescence analysis, the powdered sample was treated with various chemical reagents to give different colors. This may help to identify the purity of the drug. The results of fluorescence analysis are presented in the Tables 5.1, 5.2, 5.3, 5.4 and 5.5.

*Caulerpa scalpelliformis* emits yellowish green fluorescence at 254nm when the powder was treated with 1N aqueous Sodium hydroxide, 1N ethanolic Sodium hydroxide, 50% Sulphuric acid and 50% Nitric acid. The powder emits green fluorescence with 1N HCl at the same wavelength. The petroleum ether, benzene and water extracts show yellowish green fluorescence at 254nm while the chloroform and methanol extracts show green fluorescence. No fluorescence was observed at 365nm, when the powder was treated with various reagents such as 1N aqueous Sodium hydroxide, 1N ethanolic Sodium hydroxide, with 1N HCl, 50% Sulphuric acid and 50% Nitric acid. Similarly, various plant extracts also failed to emit fluorescence at this wavelength (Table 5.1).

*Ulva lactuca* emitted greenish yellow fluorescence at 254nm when the powdered drug was treated with 1N aqueous Sodium hydroxide, 1N ethanolic Sodium hydroxide, with 1N HCl, 50% Sulphuric acid and 50% Nitric acid. The petroleum ether, benzene, methanol and water extracts also showed greenish yellow
fluorescence at 254nm. The chloroform extract showed green fluorescence at 254nm. The plant powder emitted dark green light at 365nm when treated with 1N HCl, 50% Sulphuric acid and 50% Nitric acid and brown light when treated with 1N aqueous Sodium hydroxide and 1N ethanolic Sodium hydroxide. The petroleum ether, benzene, methanol and water extracts emitted dark green light at 365nm, while the chloroform extract emitted brown fluorescence (Table.5.2).

The plant powder and various extracts of *Padina tetrastromatica* gave out greenish yellow fluorescence at shorter UV light (254nm) and brown colored light at longer wavelength (Table.5.3).

Both the plant powder and various extracts of the brown alga *Stoechospermum marginatum* emitted yellowish green fluorescence at 254nm and dark brown fluorescence at 365nm (Table.5.4).

Red alga *Acanthophora spicifera* showed characteristic yellowish green fluorescence at 254nm when the powder was treated with various reagents. The methanol and water extracts gave out yellowish green fluorescence at 254nm. The petroleum ether, benzene, and chloroform extracts showed green fluorescence at 254nm. The plant powder and the various plant extract emitted dark green colored light at higher wavelength (Table.5.5).

Analyses of the seaweeds for various physiochemical parameters such as total ash, acid insoluble ash, sulphated ash and solvent soluble extractive values give an idea to use them as pharmatherapeutic agents if they possess promising biological activity. The physiochemical results of the algae studied are presented in Table.5.6.
The results of the physiochemical analysis prove the stability, purity and firmness of the plant and are helpful to standardize them to use as potential drugs.

The moisture content of seaweeds is usually high. In the present study, brown algae *Padina tetrastromatica* and *Stoechospermum marginatum* exhibited high percentage of moisture content. So the dried matters present in these algae are less. Green algae *Caulerpa scalpelliformis* and *Ulva lactuca* and red alga *Acanthophora spicifera* contain considerable amount of moisture content. The dried matters present in these algae are greater than in brown algae.

The ash content of the crude drug is generally the residue remaining after incineration. The ash value indicates the presence of the inorganic ions. During ashing process, organic matter gets oxidized and certain amount of volatile elements are lost. Marine algae exhibit high content of ash mainly due to the presence of sodium, potassium, calcium and magnesium and chloride and sulphate ions. Higher ash content is required to grow in the high ionic strength present in the medium of sea water. Lower the ash content better is the quality of agar formed. The ash content must be related to the base binding capacity of total solid present in seaweeds. In the present study, brown alga *Padina tetrastromatica* exhibits high percentage of total ash. The total ash content is low in the other brown alga *Stoechospermum marginatum*.

The high acid insoluble ash value indicates the presence of more of silicious matter in the drug. Nearly 60% of silica is present in the marine environment. Silica content in marine algae is either due to the bioaccumulation or due to the adherence
of minute sand particles on the algae. In the present study, acid-insoluble ash value is high in green alga *Caulerpa scalpelliformis*, and low in the other green alga *Ulva lactuca*. The brown algae *Padina tetrastrum* and *Stoechospermum marginatum* also contain less amount of acid-insoluble ash. The present study shows high sulphated ash value in *Caulerpa scalpelliformis*, and low sulphated ash value in *Ulva lactuca*, and *Stoechospermum marginatum*.

Extractive values of the crude drugs are useful for their evaluation especially when the constituents of a drug cannot be readily estimated by any other means. These values also indicate the valuable constituents present in a crude drug. In the present study, the extractive value in petroleum ether is high in the green alga *Caulerpa scalpelliformis*, and low in the other green alga *Ulva lactuca*, and red alga *Acanthophora spicifera*. Extractive value in benzene is high in *Stoechospermum marginatum*, and low in *Ulva lactuca*, and *Acanthophora spicifera*. Extractive value in chloroform is high in *Stoechospermum marginatum*, and low in *Acanthophora spicifera*. Extractive value in methanol is high in *Caulerpa scalpelliformis*, and low in *Ulva lactuca*. Extractive value in water is maximum in *Ulva lactuca*, and low in *Acanthophora spicifera*.

Among the various 'extractive values' studied, the methanol soluble and water soluble extractive values exhibited high percentage for all the algae studied. The methanol soluble extractive reveals the presence of polar compounds like glycosides, secondary metabolites such as alkaloids, flavonoids, terpenoids, steroids and their glycosides, phenols and tannins. These organic ligands possess promising
biological activities to be utilized as potential drugs. The present study shows *Caulerpa scalpelliformis* exhibiting high percentage of methanol soluble extractive, *Padina tetrastromatica*; *Stoechospermum marginatum* and *Acanthophora spicifera* also exhibit considerable percentage of methanol soluble extractives.

The water-soluble extractives indicated the presence of water-soluble matters such as sugars, amino acids and vitamins. The percentage of water-soluble extractives in the present study range from 1.66% to 47.29%. *Ulva lactuca* exhibits high percentage of water-soluble extractives. *Padina tetrastromatica* and *Stoechospermum marginatum* also exhibits considerable percentage of water-soluble extractives. The green alga *Caulerpa scalpelliformis* and the red alga, *Acanthophora spicifera* exhibits low percentage of water-soluble extractives. This is attributed to the high content of lipids in these species. This present analysis is in conformity with those algal species of the Thirumalaivasal estuary and Idinthakarai coast\textsuperscript{15} and Gulf of Mannar, Southeast coast of India\textsuperscript{11}.

**Conclusion**

- Green alga *Ulva lactuca* has two layered wide rectangular medullary cells.
- In brown alga *Padina tetrastromatica*, the outer margin of the thallus is revolute and rolled two or three time. The asexual reproductive structures namely the tetra sporangia are seen in transverse rows on one side of the thallus.
In *Stoechospermum marginatum*, there are distinct epidermal layers; the epidermal cells are small squarish, thick-walled and darkly stained. Between the epidermal layers there are 8 or 9 layers of homogeneous compact parenchyma cells.

Red alga *Acanthophora spicifera* consists of a thick epidermal layer which has prominent mucilaginous surface coating. The epidermal cells in surface view are polygonal in outline, thin walled and compact.

In fluorescence analysis, the powdered sample was treated with various chemical reagents to give different colours. This may help to identify the purity of the drug.

Brown algae *Padina tetrastromatica* and *Stoechospermum marginatum* exhibit high percentage of moisture content.

The ash value indicates the presence of the inorganic ions. Marine algae exhibit high content of ash mainly due to the presence of sodium, potassium, calcium and magnesium and chloride and sulphate ions.

The methanol-soluble and water-soluble extractive values are of high percentage for all the algae studied.

The green alga, *Caulerpa scalpelliformis* and the red alga, *Acanthophora spicifera* exhibited low percentage of water-soluble extractives. This is attributed to the high content of lipids in these species.
EXOMORPHIC FEATURES OF GREEN ALGAE

Fig. 5.1. Caulerpa scalpelliformis

Fig. 5.2. Ulva lactuca
ANATOMICAL FEATURES OF GREEN ALGA CAULERPA SCALPELLIFORMIS

Anatomy of the assimilator

Fig. 5.1.1. T.S. of the assimilator along the middle portion.

Fig. 5.1.2. T.S. of the assimilator along the middle portion enlarged.

Fig. 5.1.3. T.S. of the assimilator along the margin.

(Ec- Epidermal cells; Ep-Epidermis; Tr- Trabeculae)
ANATOMICAL FEATURES OF GREEN ALGA
CLAULERPA SCALPELLIFORMIS

Anatomy of Rhizome

Fig. 5.1.4. T.S of Rhizome-Entire view.

Fig. 5.1.5. T.S. of Rhizome - a sector enlarged.

Fig. 5.1.6. T.S. of Rhizome showing trabeculae.

Fig. 5.1.7. T.S. of Rhizome showing mucilagenous cells.

(Lo - Lobes; Ep - Epidermis; MC - Mucilagenous cells; Tr - Trabeculae; TC - Trabeculae Cells)
ANATOMICAL FEATURES OF GREEN ALGA
ULVA LACTUCA

Anatomy of the Thallus

Fig. 5.2.1. T.S. of the Thallus under low magnification.

Fig. 5.2.2. T.S. of Thallus showing epidermal layer and two layers of palisade like mesophyll cells.

Fig. 5.2.3. Thicker portion of the Thallus with palisade like layers of cells and medullary cells.

Fig. 5.2.4. Thicker portion of the Thallus enlarged.

(Ep-Epidermis; Pc-Palisade like cells; MC - Medullary Cells)
EXOMORPHIC FEATURES OF BROWN ALGAE

Fig. 5.3. Padina tetrastromatica

Fig. 5.4. Stoechospermum marginatum
ANATOMICAL FEATURES OF BROWN ALGA
PADINA TETRASTROMATICA

Anatomy of the Thallus

Fig. 5.3.1. T.S of Thallus showing revolute margin.

Fig. 5.3.2. T.S of the Thallus - a sector enlarged. (RM - Revolute margin)

Fig. 5.3.3. A horizontal row of sporangia on the lower side of the Thallus
(SW - Sporangial wall; T - Thallus; TS - Tetra sporangia; TS - Tetra spore.)

Fig. 5.3.4. A few sporangia enlarged.

Fig. 5.3.5. T.S of Thallus through rhizoids.

Fig. 5.3.6. T.S. of the Thallus through rhizoids - enlarged. (RM - Rhizoid mass; T - Thallus)
ANATOMICAL FEATURES OF BROWN ALGA 
STOECHOSPERMUM MARGINATUM 

Anatomy of the Thallus

Fig. 5.4.1. T.S of Thallus in the middle region. Fig. 5.4.2. T.S of Thallus in the marginal region.

Fig. 5.4.3. T.S. of the Thallus - Enlarged

Fig. 5.4.4. T.S of Thallus through sporangia.

( Ep - Epidermis; GT - Ground tissue; M - Margin; S - Sporangia; SP - Spore; T - Thallus)
EXOMORPHIC FEATURES OF RED ALGA

Fig. 5.5. *Acanthophora spicifera*
ANATOMICAL FEATURES OF RED ALGA
ACANTHOPHORA SPICIFERA

Anatomy of the Thallus

Fig. 5.5.1. T.S of the Thallus.

Fig. 5.5.2. Surface view of the epidermal cells.

Fig. 5.5.3. A portion of the Thallus enlarged.

Fig. 5.5.4. A portion of the Thallus enlarged showing large, dilated, lobed cells of medulla.

(Co-Cortex; Ec-Epidermal cells; Ep-Epidermis; Cu-Cuticle; Md-Medulla)
Table 5.1 Fluorescence Analysis of Green Alga 
*Caulerpa scalpelliformis*

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<th>Sl. No</th>
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<th>Long UV Light(365nm)</th>
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7 Extracts

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<td>iii) Chloroform</td>
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<tr>
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Table 5.2 Fluorescence Analysis of Green Alga *Ulva lactuca*

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<td>Brown</td>
</tr>
<tr>
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<td>3</td>
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<td>v)</td>
<td>Water</td>
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Table 5.3 Fluorescence Analysis of Brown Alga *Padina tetrastromatica*

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<th>Long UV Light(365nm)</th>
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<td>Greenish brown</td>
<td>Brown</td>
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<tr>
<td>2</td>
<td>Powder + 1N aq.NaOH</td>
<td>Pale brown</td>
<td>Greenish yellow</td>
<td>Brown</td>
</tr>
<tr>
<td>3</td>
<td>Powder + 1N alc.NaOH</td>
<td>Pale brown</td>
<td>Greenish yellow</td>
<td>Brown</td>
</tr>
<tr>
<td>4</td>
<td>Powder + 1N HCl</td>
<td>Green</td>
<td>Greenish yellow</td>
<td>Brown</td>
</tr>
<tr>
<td>5</td>
<td>Powder +50% H\textsubscript{2}SO\textsubscript{4}</td>
<td>Pale brown</td>
<td>Greenish yellow</td>
<td>Brown</td>
</tr>
<tr>
<td>6</td>
<td>Powder + 50% HNO\textsubscript{3}</td>
<td>Brown</td>
<td>Greenish yellow</td>
<td>Brown</td>
</tr>
</tbody>
</table>

7 Extracts

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>i)</td>
<td>Pet. ether (40°-60°c)</td>
<td>Brown</td>
<td>Greenish yellow</td>
<td>Brown</td>
</tr>
<tr>
<td>ii)</td>
<td>Benzene</td>
<td>Brown</td>
<td>Greenish yellow</td>
<td>Brown</td>
</tr>
<tr>
<td>iii)</td>
<td>Chloroform</td>
<td>Brown</td>
<td>Greenish yellow</td>
<td>Brown</td>
</tr>
<tr>
<td>iv)</td>
<td>Methanol</td>
<td>Brown</td>
<td>Greenish yellow</td>
<td>Brown</td>
</tr>
<tr>
<td>v)</td>
<td>Water</td>
<td>Pale brown</td>
<td>Greenish yellow</td>
<td>Brown</td>
</tr>
</tbody>
</table>
### Table 5.4 Fluorescence Analysis of Brown alga *Stoechospermum marginatum*

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Treatment</th>
<th>Day light</th>
<th>Short UV Light(254nm)</th>
<th>Long UV Light(365nm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Powder as such</td>
<td>Brown</td>
<td>Greenish brown</td>
<td>Dark brown</td>
</tr>
<tr>
<td>2</td>
<td>Powder + 1N aq.NaOH</td>
<td>Pale brown</td>
<td>Yellowish green</td>
<td>Dark brown</td>
</tr>
<tr>
<td>3</td>
<td>Powder + 1N alc.NaOH</td>
<td>Pale brown</td>
<td>Yellowish green</td>
<td>Dark brown</td>
</tr>
<tr>
<td>4</td>
<td>Powder + 1N HCl</td>
<td>Pale brown</td>
<td>Yellowish green</td>
<td>Dark brown</td>
</tr>
<tr>
<td>5</td>
<td>Powder + 50% H2SO4</td>
<td>Pale brown</td>
<td>Yellowish green</td>
<td>Dark brown</td>
</tr>
<tr>
<td>6</td>
<td>Powder + 50% HNO3</td>
<td>Pale brown</td>
<td>Yellowish green</td>
<td>Dark brown</td>
</tr>
</tbody>
</table>

#### Extracts

<table>
<thead>
<tr>
<th></th>
<th>Treatment</th>
<th>Day light</th>
<th>Short UV Light</th>
<th>Long UV Light</th>
</tr>
</thead>
<tbody>
<tr>
<td>i)</td>
<td>Pet. ether (40°-60°C)</td>
<td>Pale brown</td>
<td>Yellowish green</td>
<td>Dark brown</td>
</tr>
<tr>
<td>ii)</td>
<td>Benzene</td>
<td>Brown</td>
<td>Yellowish green</td>
<td>Dark brown</td>
</tr>
<tr>
<td>iii)</td>
<td>Chloroform</td>
<td>Brown</td>
<td>Yellowish green</td>
<td>Dark brown</td>
</tr>
<tr>
<td>iv)</td>
<td>Methanol</td>
<td>Brown</td>
<td>Yellowish green</td>
<td>Dark brown</td>
</tr>
<tr>
<td>v)</td>
<td>Water</td>
<td>Pale brown</td>
<td>Yellowish green</td>
<td>Dark brown</td>
</tr>
</tbody>
</table>
Table 5.5 Fluorescence Analysis of Red Alga *Acanthophora spicifera*

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Treatment</th>
<th>Day light</th>
<th>Short UV Light(254nm)</th>
<th>Long UV Light(365nm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Powder as such</td>
<td>Dark green</td>
<td>Dark green</td>
<td>Dark green</td>
</tr>
<tr>
<td>2</td>
<td>Powder + 1N aq.NaOH</td>
<td>Pale green</td>
<td>Yellowish green</td>
<td>Dark green</td>
</tr>
<tr>
<td>3</td>
<td>Powder + 1N alc.NaOH</td>
<td>Pale green</td>
<td>Yellowish green</td>
<td>Dark green</td>
</tr>
<tr>
<td>4</td>
<td>Powder + 1N HCl</td>
<td>Green</td>
<td>Yellowish green</td>
<td>Dark green</td>
</tr>
<tr>
<td>5</td>
<td>Powder + 50% H₂SO₄</td>
<td>Pale green</td>
<td>Yellowish green</td>
<td>Dark green</td>
</tr>
<tr>
<td>6</td>
<td>Powder + 50% HNO₃</td>
<td>Colorless</td>
<td>Yellowish green</td>
<td>Dark green</td>
</tr>
</tbody>
</table>

**Extractions**

<table>
<thead>
<tr>
<th>i)</th>
<th>Pet. ether (40°-60°c)</th>
<th>Pale green</th>
<th>Green</th>
<th>Dark green</th>
</tr>
</thead>
<tbody>
<tr>
<td>ii)</td>
<td>Benzene</td>
<td>Pale green</td>
<td>Green</td>
<td>Dark green</td>
</tr>
<tr>
<td>iii)</td>
<td>Chloroform</td>
<td>Pale green</td>
<td>Green</td>
<td>Dark green</td>
</tr>
<tr>
<td>iv)</td>
<td>Methanol</td>
<td>Brown</td>
<td>Yellowish green</td>
<td>Dark green</td>
</tr>
<tr>
<td>v)</td>
<td>Water</td>
<td>Green</td>
<td>Yellowish green</td>
<td>Dark green</td>
</tr>
</tbody>
</table>
### Table 5.6 Physicochemical characters of some Macro Algae from Tuticorin Coast

<table>
<thead>
<tr>
<th>Particulars</th>
<th><em>Caulerpa scalpelliformis</em></th>
<th><em>Ulva lactuca</em></th>
<th><em>Padina tetrastromatica</em></th>
<th><em>Stoechospermum marginatum</em></th>
<th><em>Acanthophora spicifera</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>79.95%</td>
<td>72.93%</td>
<td>91.07%</td>
<td>92.1%</td>
<td>74.94%</td>
</tr>
<tr>
<td>Dried Matter</td>
<td>20.05%</td>
<td>27.07%</td>
<td>8.93%</td>
<td>7.9%</td>
<td>25.06%</td>
</tr>
<tr>
<td>Total ash</td>
<td>21.00%</td>
<td>15.50%</td>
<td>32.61%</td>
<td>11.6%</td>
<td>19.50%</td>
</tr>
<tr>
<td>Acid-insoluble ash</td>
<td>12.00%</td>
<td>1.00%</td>
<td>1.5%</td>
<td>1.7%</td>
<td>5.1%</td>
</tr>
<tr>
<td>Sulphated ash</td>
<td>13.50%</td>
<td>6.00%</td>
<td>9.2%</td>
<td>6.0%</td>
<td>10.10%</td>
</tr>
</tbody>
</table>

#### Extractive values

<table>
<thead>
<tr>
<th>Nature of Extract</th>
<th><em>Caulerpa scalpelliformis</em></th>
<th><em>Ulva lactuca</em></th>
<th><em>Padina tetrastromatica</em></th>
<th><em>Stoechospermum marginatum</em></th>
<th><em>Acanthophora spicifera</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Pet. Ether(40°-60°C)</td>
<td>5.08%</td>
<td>0.11%</td>
<td>1.79%</td>
<td>2.62%</td>
<td>0.09%</td>
</tr>
<tr>
<td>soluble Extract</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b) Benzene</td>
<td>5.90%</td>
<td>0.03%</td>
<td>2.62%</td>
<td>6.81%</td>
<td>0.13%</td>
</tr>
<tr>
<td>soluble Extract</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c) Chloroform</td>
<td>6.78%</td>
<td>2.01%</td>
<td>3.78%</td>
<td>11.32%</td>
<td>0.12%</td>
</tr>
<tr>
<td>soluble Extract</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d) Methanol</td>
<td>21.04%</td>
<td>7.60%</td>
<td>18.25%</td>
<td>16.95%</td>
<td>12.40%</td>
</tr>
<tr>
<td>soluble Extract</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e) Water</td>
<td>7.16%</td>
<td>47.29%</td>
<td>23.95%</td>
<td>19.27%</td>
<td>1.66%</td>
</tr>
<tr>
<td>soluble Extract</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
REFERENCES


