APPENDIX

8.1 Research paper published during the study period.


Leaf Anatomical Studies on Some Mangrove Plants

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Abstract

Leaf anatomical characters of mangrove taxa namely Acanthus illicifolius, Aegiceros corniculatum, Avicennia marina, Avicennia officinalis, Bruguiera cylindrica, Ceriops decandra, Exoecaria agallocha, Lumnitzera racemosa, Rhizophora apiculata, R. mucronata, Suaeda maritima, S. monoica and Sesuvium portulacasturm were investigated. Hand sections of leaves were made at a position approximately half way between the base and apex of a sector from one side of the lamina. Petiole sections were made in the middle of the petiole and the sections were stained with aqueous safranin and mounted in glycerin jelly sealed with paraffin wax. Apart from light microscope sections, also observed under SEM microscope. The mangrove taxa showed anatomical characters which are adapted to mangrove environment even though they are from different families. With regard to epidermal characters, the mangroves of one family showed closer resemblance to the non-mangroves of the same family than to mangroves of other families. The study indicated that the epidermal characters are reliable for identification of various plant species.

Keywords: Mangrove plants, leaf anatomy, epidermal characters, scanning electron microscope.

Introduction

Plant formation consists of a peculiar assemblage of mangrove plants develop on muddy beaches, salt water areas and lagoons and are characterized by leathery leaves, sunken stomata slit roots, Pneumatophores and Viviparous fruits. These plants are well adapted to changing biological, chemical and physical traits of this environment through various xeromorphic properties, including morphology, anatomy and physiology. Plants of the mangrove community belong to many different genera and families, most of which are not closely related to one another phylogenetically (Chapman, 1976). Approximately eighty species of plants belonging to thirty genera in over twenty families (most of them belong to Rhizophoraceae) are recognized worldwide (Tomlinson, 1986). The present investigation was intended to study the leaf anatomical structures of some mangroves collected from Thaandavarayan sozhanpettai, a coastal village in Cuddalore district of Tamil Nadu.

Materials and methods

The mangrove plants examined were Acanthus illicifolius L. (Acanthaceae), Aegiceros corniculatum (Myrsinaceae), Avicennia marina, A. officinalis (Avicenniaceae), Bruguiera cylindrica, Ceriops decandra, Rhizophora mucronata and R. apiculata (Rhizophoraceae), Exoecaria agallocha (Euphorbiaceae), Lumnitzera racemosa (Combretaceae), Suaeda monoica, S. maritima (Chenopodiaceae) and Sesuvium portulacastrum (Aizoaceae). Mature leaves with petiole of the plants were collected from the Thaandavarayan sozhan pettai, a coastal village in Cuddalore district of Tamil Nadu. Hand sections of leaves were made at a position approximately half way between the base and apex of a sector from one side of the lamina. Petiole sections were made in the middle of the petiole. The sections are stained with aqueous safranin and were mounted in glycerin jelly. The cover glass is sealed with paraffin wax. The slides were observed under light microscope and photographed using Olympus digital camera attached with Olympus trinocular microscope. SEM photographs were also prepared for all these anatomical sections.

Results

Leaves in general are dorsiventral and hypostomatic in most of the species except in Lumnitzera racemosa where the leaves are isobilateral and amphistomatic. In Suaeda species and in Sesuvium portulacastrum the leaves are almost cylindrical in outline and the stomata found all over the epidermis. Usually mangrove leaves are succulent. The highest lamina thickness occurs in Suaeda maritima (2786.6 ± 82.5 μm) and lowest in Bruguiera cylindrica (315.3 ± 11 μm). All species have a thick cuticle over the epidermis. The epidermal cells cutinized wholly except Avicennia species and Bruguiera cylindrica, where only the tangential wall of the epidermal cells are cutinized. The cuticular surface is usually smooth except Avicennia species where, it is interrupted by uiseriate epidermal hairs (Table 1).
In most of the species, both the adaxial and the abaxial epidermal cells are more or less similar in size except in *Avicennia officinalis*, *Ceriops decandra* and *Acanthus illicifolius* where the adaxial epidermal cells are larger in size in comparison to those of abaxial cells. The epidermal cells are polygonal in outline with more or less straight walls in all species studied except *Ceriops decandra* and *Excoecaria agallocha*. In *Ceriops decandra*, the wall of the epidermal cells is sinuous, whereas in *Excoecaria agallocha* it is wavy.

The stomata are of anomocytic type in *Aegiceros corniculatum*, diacytic in *Acanthus illicifolius*, Cyclocytic in *Ceriops decandra*, in all other it is paracytic. Cuticular striations radiating from the stomata towards the walls of the subsidiary cell are recorded in *Excoecaria agallocha*. In *Rhizophora apiculata*, the subsidiary cells having papillary projections. Both glandular and non-glandular trichomes were observed in leaves of *Avicennia* species. Each glandular trichome or salt gland having a stalk cell and a head comprising of variable number of cells found on both adaxial and abaxial surfaces of leaves, whereas non-glandular trichomes are multilayered with a stalk of 2 to 3 cells with an awl shaped terminal cell observed abundantly all over the lower epidermis. Glandular trichomes similar to that of *Avicennia* is also observed in *Aegiceros corniculatum* (Figs. 1-14).

The thickness of the upper epidermis ranging from 86.1 ± 2.7 µm in *Suaeda maritima* to 8.4 ± 0.55 µm in *Aegiceros corniculatum* and thickness of lower epidermis ranging from 22 ± 0 µm in *Lumnitzera racemosa* to 9.0 ± 0.55 µm in *Aegiceros corniculatum*.

In all species studied, the mesophyll differentiated into palisade and spongy tissues except *Lumnitzera racemosa*, where only palisade layer is present on both sides. The palisade tissue below the upper epidermis is two layers in thickness in *Ceriops decandra*, *Acanthus illicifolius* and *Suaeda species* and one layer in thickness in *Bruguiera cylindrica* and more than two layers in thickness in the rest. Water storing tissues of varying proportions has been observed in all species. In most of the species, the water storing tissue found as a hypoderm except *Lumnitzera racemosa*, where it is centrally located in between the upper and lower palisade layer. The water storing tissue is uniseriate in *Bruguiera cylindrica*, biseriate in *Ceriops decandra* and *Acanthus illicifolius*, multiseriate in other species observed. In *Lumnitzera racemosa*, the palisade tissue found in two layers on both sides of the epidermis. The palisade and spongy ratio was highest in *Excoecaria agallocha* (1.51 ± 0.02 µm) and lowest in *Ceriops decandra* (0.24 ± 0.03 µm).

### Table 1. Laminar characters of some mangroves.

<table>
<thead>
<tr>
<th>Species</th>
<th>Thickness of the Lamina (in µm)</th>
<th>Thickness of the UE (in µm)</th>
<th>Thickness of the LE (in µm)</th>
<th>Thickness of the Palisade layer (in µm)</th>
<th>Thickness of the Spongy layer (in µm)</th>
<th>P/S Ratio (in µm)</th>
<th>Thickness of the WST (in µm)</th>
<th>Percent of WST to Total Lamina Thickness (in µm)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Aegiceros corniculatum</em></td>
<td>359.3±5.5</td>
<td>8.4±0.55</td>
<td>9.0±0.55</td>
<td>113.6±8.2</td>
<td>141.1±8.2</td>
<td>0.7±0.0</td>
<td>176±11</td>
<td>48.9±3.8</td>
</tr>
<tr>
<td><em>Acanthus illicifolius</em></td>
<td>601.3±11</td>
<td>38.5±5.5</td>
<td>22±0.0</td>
<td>157.6±1.6</td>
<td>300.6±5.5</td>
<td>0.52±0.0</td>
<td>82.5±5.5</td>
<td>13.7±1.1</td>
</tr>
<tr>
<td><em>Avicennia marina</em></td>
<td>539±11</td>
<td>22±0.0</td>
<td>15±1.6</td>
<td>148.5±5.5</td>
<td>129.8±9.9</td>
<td>1.13±0.1</td>
<td>223.6±5.5</td>
<td>41.4±0.6</td>
</tr>
<tr>
<td><em>Avicennia officinalis</em></td>
<td>528±16.5</td>
<td>20.1±2.7</td>
<td>11±0.0</td>
<td>165±11</td>
<td>115.5±8.2</td>
<td>1.36±0.2</td>
<td>216.3±16.5</td>
<td>40.9±1.8</td>
</tr>
<tr>
<td><em>Bruguiera cylindrica</em></td>
<td>315.3±11</td>
<td>22±0.0</td>
<td>49.5±8.2</td>
<td>185.1±2.7</td>
<td>0.26±0.045</td>
<td>36.6±2.7</td>
<td>11.6±0.9</td>
<td></td>
</tr>
<tr>
<td><em>Ceriops decandra</em></td>
<td>682±11</td>
<td>30.4±2.7</td>
<td>20.1±27.0</td>
<td>110±11</td>
<td>440±11</td>
<td>0.24±0.03</td>
<td>81.4±5.5</td>
<td>11.9±0.7</td>
</tr>
<tr>
<td><em>Excoecaria agallocha</em></td>
<td>517±11</td>
<td>20.1±2.7</td>
<td>17.9±1.6</td>
<td>270.2±5.5</td>
<td>177.4±3.3</td>
<td>1.51±0.02</td>
<td>31.1±2.7</td>
<td>6.0±0.6</td>
</tr>
<tr>
<td><em>Rhizophora apiculata</em></td>
<td>535.3±5.5</td>
<td>22±0.0</td>
<td>14.6±2.7</td>
<td>165±11</td>
<td>150.3±8.2</td>
<td>1.0±0.05</td>
<td>183.3±16.5</td>
<td>34.2±3.0</td>
</tr>
<tr>
<td><em>Rhizophora Mucronata</em></td>
<td>627±11</td>
<td>22±0.0</td>
<td>14.6±1.6</td>
<td>176±11</td>
<td>165±11</td>
<td>1.0±0.0</td>
<td>256.6±22</td>
<td>40.9±2.8</td>
</tr>
<tr>
<td><em>Lumnitzera racemosa</em></td>
<td>1279.6±16.5</td>
<td>22±0.0</td>
<td>22±0.0</td>
<td>132±11</td>
<td>-</td>
<td>-</td>
<td>430.8±2.7</td>
<td>33.6±0.6</td>
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<tr>
<td><em>Suaeda maritima</em></td>
<td>2786.6±82.5</td>
<td>86.1±2.7</td>
<td>-</td>
<td>110±11</td>
<td>-</td>
<td>-</td>
<td>990±22</td>
<td>35.5±0.7</td>
</tr>
<tr>
<td><em>Suaeda monica</em></td>
<td>1210±22</td>
<td>53.1±2.75</td>
<td>-</td>
<td>152.1±13.7</td>
<td>-</td>
<td>-</td>
<td>315.3±5.5</td>
<td>26±0.9</td>
</tr>
</tbody>
</table>

UE-Upper epidermis, LE-Lower epidermis, WST-Water storage tissue, P/S ratio-Palisade spongy ratio.
Fig. 1. *Acanthus ilicifolius* - lower epidermis.

Fig. 2. *Aegiceros corniculatum* - lower epidermis.

Fig. 3. *Avicennia marina* - lower epidermis.

Fig. 4. *Avicennia officinalis* - lower epidermis.

Fig. 5. *Bruguiera cylindrica* - lower epidermis.
Fig. 6. *Ceriops decandra* – lower epidermis.

Fig. 7. *Excoecaria agallocha* – lower epidermis.

Fig. 8. *Lumnitzera racemosa* – upper and lower epidermis.

Fig. 9. *Rhizophora apiculata* – lower epidermis.

Fig. 10. *Rhizophora mucronata* – lower epidermis.
Idioblasts and stellate sclerieds are observed in the mesophyll of Bruguiera cylindrica, Lumnitzera racemosa and Rhizophora mucronata. Tannin containing cells are also observed in Bruguiera cylindrica.

The outline of the petiole observed in various shapes in different species. Thick cuticle covering the epidermis. The hypodermis consists of 2 to 3 layers of collenchyma in all species observed. Ground tissue consists of loosely arranged parenchyma cells, where as in Rhizophora mucronata, it is aerenchymatous. Stellate idioblasts are also observed in the ground tissue of Rhizophora mucronata.

The vascular bundle is medullated in Rhizophora mucronata, Rhizophora apiculata, Avicennia marina and Bruguiera cylindrica or the vascular bundles are in the form of deep arc or flat arc in Avicennia officinalis, A. marina, Aegiceros corniculatum and Lumnitzera racemosa and is represented by 3 or more discrete vascular bundles in Excoecaria agallocha, Acanthus illicifolius and Sesuvium portulacastrum.

Discussion
In the family Rhizophoraceae, the leaf anatomy of four taxa was studied in the present investigation and they are Rhizophora mucronata, R. apiculata, Ceriops decandra and Bruguiera cylindrica.
The epidermal cells in all these species are having slightly curved walls. Stomata are sunken and cyclocytic. In Rhizophora apiculata, the stomatal ledge is clear. But in Rhizophora mucronata, it is not clear and also in Bruguiera cylindrica and Ceriops decandra. In Poga of this family, the stomata are anomocytic and paracytic in Anisophytelea and Combretocarpus and showing various intermediate types in Gynotroches, Cossostylis, Cassipourea and Anopyx (Tobe and Raven, 1988). In Lumnitzera, there are two species reported so far, they are Lumnitzera racemosa and L. littorea. These two species are not readily distinguished using epidermal characters except the size of the stomata and epidermal characters. There are two species in Ceriops, namely Ceriops decandra and C. tagal. In Ceriops tagal the subsidiary slightly overarching the guard cells than in Ceriops decandra. Except this character, there is no character found to distinguish these two species. In Bruguiera, there are five species reported, they are Bruguiera cylindrica, B. gymnorrhiza, B. hainesic, B. sexangula, B. parviflora and B. exaxistata. These species differ only in their size of the epidermal cells and stomata. In Bruguiera cylindrica and B. gymnorrhiza, the stomata are small compared with those of other Rhizophoraceae mangroves. The epidermal cells are also smaller in size in these two species compared to other species of Bruguiera. In Rhizophora, there are eight species reported so far; they are Rhizophora apiculata, R. annamalayana, R. mucronata, R. lamarckii, R. mangie, R. harrisonii, R. racemosa and R. stylosa (Das and Ghose, 1996). Among these two species studied in the present work, in Rhizophora apiculata, the lateral subsidiary cells overarching the guard cells, where as in Rhizophora mucronata there is no such overlapping. Among the other species studied, in Rhizophora mangie, R. harrisonii, R. racemosa and R. annamalayana there is no overlapping of subsidiary cells over the guard cells. But it is seen in Rhizophora stylosa and R. lamarckii. Apart from this character, there is no other character is there to separate or distinguish the various species. In most of the genera, the trichomes are absent including the mangrove genera and wherever it is present it is only sparse except Macarista sp. where they may be dense and clustered. Among the Combretaceae taxa, three genera are mangrove plants and they are Lumnitzera, Laguncularia and Conocarpus (Stace, 1965). Normally leaves in Combretaceae members are dorsiventral in these three genera and in Macropterenthes the leaves are isobilateral. In dorsiventral leaves, in these three genera, the mesophyll is differentiated into palisade and spongy tissues. The palisade tissue consists of one layer of cells below the upper epidermis and a broad spongy zone. In Lumnitzera the leaves are isobilateral, similarly in other two mangrove genera also the leaves are isobilateral apart from the non-mangrove genus Macropterenthes.

The stomata are anomocytic in most of the members of Combretaceae but it is paracytic in strephomena and cyclocytic in Lumnitzera and Languncularia. Glandular hairs are present in most of the genera of Combretaceae including the mangrove genus Languncularia but it is absent in other two mangrove genera.

In Avicennia there are twelve taxa reported so far, they are Avicennia marina var marina, var. resinifera, var. acutissima, var. rumphiana, A. bicolor, A. alba var alba, A. eucalyptifolia, A. schaceriana, A. tonduzii, A. germanins, A. Africana and A. officinalis. Among these, two species were studied namely Avicennia officinalis, Avicennia marina var. marina. In Avicennia officinalis, the glandular trichomes are 20-25 per mm whereas in Avicennia marina var. marina there are more than 50 glandular hairs per mm. Among the other species studied, Avicennia marina, var. resinifera, var. rumpriana, var. acutissima, Avicennia bicolor, Avicennia alba, var. resinifera, A. eucalyptifolia, the number of glandular trichomes was less than 25 per sq. mm where as in the remaining taxa, it is more than 25 per mm. In the family Chenopodiaceae, two taxa were studied namely Suaeda maritima and S. monoica. These two taxa showed cylindrical leaves. These cylindrical leaves not only found in these taxa and most of the other members of Chenopodiaceae. The stomata are paracytic and the epidermal cells are polygonal. In Aegiceros corniculatum, the stomata are anomocytic and they are irregularly arranged. In Acanthus illicifolius, glandular hairs are present on the upper epidermis and the stomatal ledge clearly seen over the guard cells. The stomatal ledge also seen in A. corniculatum. Another similarity between these two genera is the stomata which is not sunken unlike other mangroves. In Excoecaria agallocha, many cuticular striations radiating from the stomata towards the walls of the subsidiary cells. These may be the character of this species. This is also noticed by Seshavatharam and Srivalli (1989) in their study.

**Conclusion**

From this study it is concluded that certain characters like thick cuticle, water storage tissue, extensive palisade, salt glands and trichome exhibited by most of the mangrove species appears to ecophysiological adaptations. But as suggested by Stace (1966), that in their anatomical characters, the mangrove species exhibit closer affinities to non-mangrove species of their family than to mangrove of other families. This character includes isobilateral nature of leaves in some plants like lumnitzera and cylindrical nature of leaves in Chenopodiaceae members and the type of stomata and epidermal cells.

**References**

Studies on Phytochemical Constituents of Some Selected Mangroves

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Abstract

Extract of mangrove plants are widely used in folk medicines since time immemorial. The phytochemicals found in these plants must be known to find out the medicinal aspects of these plants. So the present study elucidated various phytochemicals found in the leaves of selected mangrove plants. The mangrove plants examined in the present study are Acanthus ilicifolius L. (Acanthaceae), Aegiceras corniculatum (Myrsinaceae), Avicennia marina and A. officinalis (Avicenniaceae), Bruguiera cylindrica, Ceriops decandra, Rhizophora mucranata and R. apiculata (Rhizophoraceae), Excoecaria agallocha (Euphorbiaceae), Lumnitzera racemosa (Combretaceae), Suaeda monoica and S. maritima (Chenopodiaceae). Preliminary phytochemical screening revealed the presence and absence of tannins, alkaloids, steroids, glycosides, flavonoids, phenols, saponins, terpenoids in these plants.

Keywords: Mangrove plants, folk medicines, phytochemicals, tannins, alkaloids, terpenoids.

Introduction

The mangroves are marvel of nature, ecological wonder and scenic splendor. These plants grow in mud flats and shallow water coastal areas where the water is generally brackish. These areas are tough places for plants to grow. But mangroves survive in these harsh conditions because they are highly adaptable to their environment in terms of their anatomy, physiology and morphology. They contain many bioactive compounds of toxicological, pharmacological and ecological importance. These compounds are synthesized by primary or secondary metabolism of living organism. Secondary metabolites are chemically and taxonomically extremely diverse compounds with obscure function. The knowledge of chemical constituents of these plants is desirable to understand herbal drugs and their preparation. Many workers have referred the usefulness of mangrove plants in traditional medicine (Kokpal et al., 1990; Premanathan et al., 1992; 1996). Due to their medicinal values, mangrove plant extracts have been used for centuries by the local people as folk medicine for curing many health disorders. The present study was undertaken to investigate the presence or absence of phytochemicals of some mangroves.

Materials and methods

The mangrove plants examined were Acanthus ilicifolius L. (Acanthaceae), Aegiceras corniculatum (Myrsinaceae), Avicennia marina and A. officinalis (Avicenniaceae), Bruguiera cylindrica, Ceriops decandra, Rhizophora mucranata and R. apiculata (Rhizophoraceae), Excoecaria agallocha (Euphorbiaceae), Lumnitzera racemosa (Combretaceae), Suaeda monoica and S. maritima (Chenopodiaceae).

The leaves of the following mangroves were collected from Pitchavaram mangrove forest, Cuddalore District, Tamil Nadu. The collected leaves were washed with tap water and shade dried at room temperature. The dried leaves were powdered using electrical blender. Ten grams of material was stirred overnight in 70% methonal (100 mL) and then centrifuged at 10,000 rpm for 10 min at 4°C. The resultant supernatant was collected and the methanol was removed by evaporation. This extract was used for further phytochemical analysis.

Qualitative phytochemical tests for the identification of alkaloids, flavonoids, steroids, tannins, terpenoids, saponins, glycosides and phenols were carried out in the extract as per the method described by Harborne (1973), Sofowora (1993) and Trease and Evans (1989).

Test for Tannins: A small portion of the extract was diluted with 20 mL of distilled water and boiled in a boiling tube. Then few drops of 0.1% ferric chloride was added. The appearance of brownish green or blue-black colour indicates the presence of tannins.

Test for Saponins: One mL of the extract was diluted with 20 mL of distilled water and shaken vigorously. The formation of stable foam indicates the presence of saponins.

Test for Flavonoids: About 1 mL of the extract was mixed with few fragments of magnesium ribbon and concentrated hydrochloric acid. The appearance of pink or magenta-red colour indicates the presence of flavonoids.
Test for Phenols: A small portion of the extract was mixed with 2 mL of ferric chloride solution. The appearance of green or blue colour indicates the presence of tannins.

Test for Alkaloids: Two mL of the extract was mixed with 0.2 mL of 1% HCl. Then 1 mL of Mayer’s reagent was added. Any precipitate or turbidity indicates the presence of alkaloids.

Test for Steroids: A small portion of the extract was mixed with 2 mL of acetic anhydride. Then 2 mL of sulphuric acid was added by the sides of the test tube. The appearance of bluish-green or violet colour indicates the presence of steroids.

Test for Terpenoids: A small portion of the extract was mixed with 2 mL of chloroform. Then 3 mL of sulphuric acid was carefully added. The appearance of reddish brown or pinkish brown ring/colour indicates the presence of terpenoids.

Test for Glycosides: A small portion of the extract was mixed with 2 mL of glacial acetic acid containing 1-2 drops of ferric chloride solution. The mixture was then poured into another test tube containing 2 mL of concentrated sulphuric acid. The appearance of brown ring indicates the presence of glycosides.

Results and discussion

The phytochemicals found in various taxa of mangrove plants are shown in Table 1. The leaf extract of Acanthus ilicifolius shows the presence of phytochemical compounds such as alkaloids, flavonoids, glycosides, phenols, saponins, tannins and terpenoids. The same phytochemical compounds were reported by Ganesh and Vennila (2011) in their study. Amer et al. (2004) extracted novel alkaloids namely 6-hydroxybenzoxazolinone, 4-hydroxyacanthamine and acanthaminoside from Acanthus arboresus in their study. The preliminary phytochemical analysis of Avicennia marina and A. officinalis extract showed alkaloids, phenols, flavonoids, tannins and terpenoids.

In the extract of A. marina, saponins are present but it was absent in A. officinalis. Similarly in the extract of A. officinalis, glycosides and steroids are present but they are absent in the extract of A. marina. In the family Rhizophoraceae four taxa Bruguiera cylindrica, Ceriops decandra, Rhizophora apiculata and R. mucranata are evaluated for phytochemicals. The phytochemicals present in all the four taxa were flavonoids, saponins and terpenoids. The glycosides are absent in Bruguiera cylindrica, Ceriops decandra and Rhizophora apiculata but it is present in R. mucranata. Except glycosides, all other phytochemicals studied were present in Ceriops decandra. Among the two Rhizophora species studied, all the above mentioned phytochemicals were present in Rhizophora mucranata but glycosides and tannins were absent in R. apiculata. Among the two Suaeda species studied, except terpenoids all other phytochemicals were present in Suaeda monoica. But saponins were absent in S. maritima. The presence of these chemicals in these plants shows the maximum activity against the various bacterial strains (Patra et al., 2009). Most of these plants showed presence of phenolic compounds which are toxic to microbial pathogens (Aboaba et al., 2006). Similarly flavonoids present in these plants are preventing the oxidative cell damage and having strong anticancer activity (Okwu, 2004). Saponins have the property of cholesterol binding and bitterness (Okwu, 2004). Alkaloids found in these plants are used as basic medicinal agents for analgesic, antispasmodic and antibacterial effect (Okwu, 2004). Saponins present in these plants are considered to be antifungal agents and tannins prevent the growth of the microorganism by precipitating nutritional microbial proteins.

Conclusion

This work is an attempt to find out the phytochemicals present in the various mangrove taxa. This research may lead to the development of a phytomedicine to act against pathogenic microbes. Further research is necessary to extract the antibacterial compounds from these plants and this will give a platform for further phytochemical and pharmaceutical applications.
References