



A Review on Phytochemical and Pharmacological activities of *Syringodium isoetifolium*

Kalaivani P, Kavitha D, Vanitha V*

Department of Biochemistry, Vels Institute of Science, Technology and Advanced Studies, Pallavaram, Chennai-600117, Tamil Nadu, India

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ABSTRACT

Seagrass are marine plants, grown in saline environments and fully submerged in the sea. They are widely distributed along the tropical and subtropical regions. A seagrass called, *Syringodium isoetifolium* comes under the family Cymodoceaceae, this grass is otherwise called as noodle grass. Phytochemical compounds such as flavonoids, terpenoids coumarins, xanthoproteins, sugars, carboxylic acids can be extracted by the solvents such as methanol, hexane, and acetone. *Syringodium isoetifolium* has pharmacological activities such as antioxidant, antihemolytic, antibacterial cytotoxicity, and antifungal activity. During photosynthesis, lacunal gas is discharged from lacunae, and it is composed of oxygen and nitrogen. Pheophytin a compound was isolated from the crude extract of *Syringodium isoetifolium* by treating it with human pathogens. Binding sites of the pathogen can be found by the Molecular docking study. In this article, we discuss about the phytochemical constituents, pharmacological activities, and morphological characteristics of *Syringodium isoetifolium*.



*Corresponding Author

Name: Vanitha V

Phone: 9941709668

Email: vanitha.sls@velsuniv.ac.in

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lites (Amudha *et al.*, 2017). Seagrass are grown in a saline environment and are a unique group of marine flowering plants that are fully submerged in the sea. They influence the ecological properties such as the physical, chemical, and biological environment. Marine animals like sea turtles, manatees, and dugongs has a good food source, because of seagrass and it may also provide services, like production of organic carbon, it exports the nutrient cycling, also involves the sediment stabilization.

Distribution

The marine environment colonizes the other plant groups that are salt marsh plants, marine algae, and mangroves. They have unique physiological characteristics and low species diversity, seagrass are successfully colonized in the polar seas. Seagrass also includes internal gas transport, submarine pollination, epidermal chloroplast and marine dispersal due to its unique ecological and morphological adaptation. Seagrass also provides oxygen to their roots and rhizomes, and they usually grow in highly reducing sediments with the toxic sulfide levels. They are responsible for the environmental

INTRODUCTION

Marine plants are distributed all over the world and serves as a breeding, feeding for marine organisms (Sakayaroj *et al.*, 2010). In response to physical, chemical, and biological changes in the environment, seagrass produces the bioactive compound, which can be used in the treatment of fever, skin disease, muscle pain, and wound healing. Under stress conditions, seagrass acts as a defence mechanism due to the production of secondary metabo-

changes because of its high light requirement. During the evolutionary time, there will be a change in the sea level, atmospheric carbon dioxide (CO₂) concentration and water temperature and also physical modification. The high pressure results in the degradation of estuaries and coastal seas (Orth *et al.*, 2006).

Seagrass are widely distributed along temperate and tropical coastlines of the world. Seagrass mainly found in estuaries, bays and coastal waters from the mid-region down to depths of 50 or 60 meters. There are 12 major divisions found around the world, but today we can see approximately 72 different species. The major group of seagrass is *Cymodocea serrulata*, *Halodule uninervis*, *Syringodium isoetifolium*, and *Halodule pinifolia* (Short *et al.*, 2007).

In India, the rich growth of seagrass and marine algae composition are seen in the Andaman Islands and also in Lakshadweep. A maximum number of species and the extensive seagrass meadows occur in the Tamilnadu coast. An article says that the seagrass were observed from the intertidal to subtidal regions down to 8m depth. Growth of seagrass is attributed mainly due to salinity, clarity of the water and also due to sandy substratum. In India, one hundred species of marine algae were recorded from the seagrass (Jagtap, 1991).

Causes for seagrass declines

The growth of seagrass may be decreased due to the environment changes like extreme climate conditions and also due to biological changes. Hurricanes, Earthquakes, disease are the natural disturbances that cause seagrass declines. An increase in sea level concentration, sea surface temperature, the intensity of storms, and frequency may extremely affect the growth of seagrass. These fluctuations in the regional and global, excess nutrients or sediments also may increase the seagrass decline. The activities of humans which may pollute the seawater may cause losses of seagrass habitat (Short and Wyllie-Echeverria, 1996).

Effects of temperature, nutrition on seagrass growth

Biotic and abiotic factors that influence plant metabolism may control the productivity of seagrass. The factors such as temperature, light, and inorganic nutrients may control the seagrass growth, but the light requirements may vary among species due to a unique morphological adaptation of each species. The optimal growth temperature of species may vary between 11.5 °C and 26°C and for tropical and subtropical species is between 23 °C

and 32 °C (Lee *et al.*, 2007).

Nutritive value of seagrass

Marine species explains about the primary and secondary metabolism lives in freshwater habitats, and inland A leaf of seagrass such as *Cymodocea serrulata*, *Halodule uninervis*, and *Syringodium isoetifolium* has both macronutrients (Phosphorous, Potassium, Calcium, Magnesium, and Sodium) and micro nutrients (Zinc, Iron, Nickel, Cadmium, Copper, and Chromium) Composition of Protein, Carbohydrates, Lipids were high in *Cymodocea serrulata*, *Halodule uninervis* whereas in *Syringodium isoetifolium* it is very low (Jeyasanta *et al.*, 2018).

Medicinal uses

Seagrass used for a remedial purpose, such as skin diseases, muscle pain, wounds, treatment of fever and stomach problems (Kannan *et al.*, 2013). Seagrass also provides dietary fiber, minerals, vitamins, amino acids, and fatty acids to the marine species (Jeevitha *et al.*, 2013). Seagrass were used as a livestock feed, fertilizer, also used as food for marine species, as shown in Table 1. They also rich in protein, fiber, and lipid, and the beneficial effect of this is, it will cure obesity and diabetes. There is good interaction between seagrass and humans. A wide range of ecological services which include instrumental, spiritual, and religious can be provided by seagrass (Torre-Castro and Rönnbäck, 2004).

The compounds present in seagrass are highly anti-oxidative in nature, and under stress conditions, they produce secondary metabolites as defense mechanism (Subhashini *et al.*, 2013). Chlorophyll and Carotenoids is highly present in seagrass that acts as vitamins and antioxidants. Recent research increases the search on novel compounds from seagrass, and they have high contents of antioxidants like polyphenols, terpenoids, flavonoid, tannins, and saponins (Ansari and Ghanem, 2019).

Botanical aspects of *Syringodium isoetifolium*

Seagrass are similar to each other because they are a highly diverse species. The botanical aspects of each species can differentiate it from each other (Wild Fact Sheets, 2005).

Habitat

Seagrass meadows survive a range of environmental conditions in coastal bays, reefs, estuarine and deepwater habitat. The photosynthesis process can be seen minimum in *Thalassodendron ciliatum* and maximum in *Syringodium isoetifolium*. Change in the light climatic condition and light attenuation may lead to the absence of photosynthetic performance (Campbell *et al.*, 2007)

Table 1: The Common name and medicinal use of five seagrass seen in the Indian coastal region

Seagrass	Common name in Tamilnadu	Medicinal use
<i>C.serrulata</i>	Karumbu pasi, Periya korai pasi, Periya thazhai pasi	Paste from leaves used to treat wounds
<i>C.rotundata</i>	Alai varai, Kadal korai, Vellai thazhai pasi	They were eaten as food; Like the potato, the root has a calorific value
<i>H.pinifolia</i>	Nedung korai, Neetu korai, Aringampul pasi	Used as cattle feed and manure
<i>H.uninervis</i>	Kothu korai, Panjipul pasi	Used as fertilizer
<i>S.isoetifolium</i>	Neer pasi, Oosi pai, Nool pasi	Fresh leaf juice consume to ease acid reflux

C.rotundata: *Cymodocea rotundata*, *C.serrulata*:*Cymodocea serrulata*, *H.pinifolia*: *Halodule pinifolia*, *H.uninervis*: *Halodule uninervis*, *S.isoetifolium*: *Syringodium isoetifolium* (Bharathi et al., 2016)

Taxonomic Classification

Seagrass are marine species, and they are functional group and not a taxonomic group, of angiosperms i.e., flowering plants (Hartog et al., 2006).

Kingdom: Plantae

Division: Magnalophyta (Angiosperms)

Class: Liliopsida

Subclass: Alismatidae

Order: Alismatales

Family: Cymodoceaceae

Genus: *Syringodium*

Species: *Syringodium isoetifolium*

Among all the seagrass, one of the major trophical seagrass is *Syringodium isoetifolium* (Figure 1). *Syringodium* belongs to the family cymodoceaceae. It is described as a genus in 1860. *Syringodium isoetifolium* is otherwise called as Noodle grass, as shown in Figure 1.

It can be found in tropical and subtropical marine environments. It is rarely found in shallow intertidal areas (Bharathi et al., 2016). It appears to respond rapidly to increased nutrient availability. In Tamilnadu, *S.isoetifolium* is commonly called as Neer pasi, Oosi korai, Nool pasi. Long spaghetti like leaves can be seen in *S.isoetifolium*, and they can nutrients and gas through thin cuticle but lacks stomata. *S.isoetifolium* uses bicarbonate (HCO_3^-) as an inorganic carbon (Bharathi et al., 2016).

Reproduction

Syringodium isoetifolium reproduces under temperature ranges from 20-26°C, and flowering was induced under continuous light.

They are rapid asexual colonizer of disturbed plots and have the fastest growth of horizontal rhi-



Figure 1: The Noodle grass of *Syringodium isoetifolium*

zome (Rasheed, 2004).

Types of Species

There are two types of species.

Syringodium filiforme – shores of Gulf of Mexico, Caribbean, Venezuela, Central America (Mcmillan, 1978). During autumn, winter, and spring, the thermal condition may enhance the production of *Syringodium filiforme*. The optimal temperature exceeds during summer, which reduces the production of *Syringodium filiforme* (Barber and Behrens, 1985).

Syringodium isoetifolium – Western Pacific shores including Red Sea, South China, Persian Gulf, Maldives, Andaman and Nicobar, Lakshadweep. Present in subtidal region (Jagtap, 1991).

Morphological characters

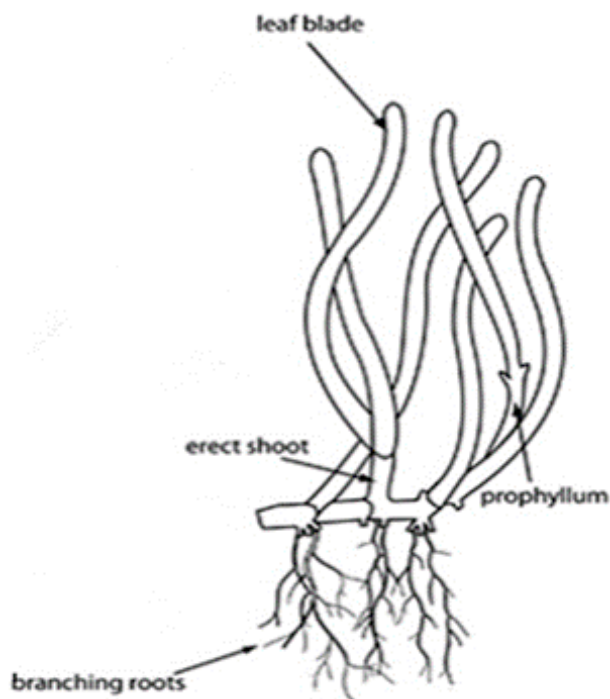


Figure 2: Morphological features of seagrass

Syringodium leaves have uniformly small epidermal cells and large secretory cells. The leaves of *Syringodium* are 5-10cm long; they can grow up to 50cm long. A centre longitudinal bundle is present, and several air lacunae are present in mesophyll tissues. They have only vascular bundle but no fibre bundle. The sheath cells surround the vascular bundle, which may reduce the apoplastic exchange of solutes and water. The seagrass has thin cuticle leaves has a layer called electron transparent. *Syringodium isoetifolium* has two types of leaf blades normal thin wall with large legume and thick wall with reduced legumes (Kuo, 1993).

The Leaves of *Syringodium isoetifolium* were cylindrical and brittle, so the growth of the leaves increases from the leaf base to the leaf tip. This seagrass has tubular leaves while the other seagrass are flat. The rhizomes are slender, and the shoots emerge from these rhizomes have 2-3 leaves, as shown in Figure 2, (Aioi and Pollard, 1993).

Phytochemical constituents

The phenolic compounds, Alkaloids, carbohydrates, proteins, and amino acids, tannins, phytosteroides, saponins, flavonoids, terpenoids, cardiac glycosides, sugars, coumarins, Carboxylic acids, quinines, xanthoproteins are the Phytochemical compounds present in seagrass. These Phytochemical compounds can be obtained by the following extractions like ethanol, methanol, acetone, hexane, as shown in Table 2.

The study of the phytochemical properties of

seagrass is essential because it acts as a food source (Mani et al., 2012). Six seagrass species such as *Syringodium isoetifolium*, *Enhalus acoroides*, *Halodule pinifolia*, *Thalassia hemprichii*, *Cymodocea serrulata*, *Cymodocea roundata* were extracted and tested for its antioxidant property. Results of this test show that high phenolic, tannin, and vitamin E content is seen in *S.isoetifolium* and High Flavonoid levels were seen in *C.serrulata* and vitamin C in *C.rotundata* (Rengasamy et al., 2013).

Phenolic compounds

Phenolic acids such as p-coumaric acid, caffeic acid, ferulic acid, protocatechuic acid, p-hydroxybenzoic acid, vanillic acid, gentisic acid, and Gallic acid present in *S.isoetifolium* (Zapata and Mcmillan, 1979). Seagrass has a unique presence of sulfated flavones, which were not present in *S.isoetifolium* (Mcmillan et al., 1980). Phenolic compounds present high level in *S.isoetifolium* which has high antioxidant activity that scavenges the toxic free radicals and reactive oxygen species such as Superoxide radical (O_2^-), hydroxyl radical (OH), peroxide radical (ROO) and nitric oxide (NO) radicals (Girija et al., 2013).

Pharmacological activities

Phytochemical constituents present in seagrass play an important role in the pharmaceutical industry. They exhibit antibacterial, antioxidant, anti-tumor activity. Humankind can continue its healthiness by the use of the plan and plant-derived medicinal products. Among them, seagrass *Syringodium isoetifolium* shows a wide range of pharmacological activities such as antibiotic, antihemolytic, cytotoxicity, antibacterial, and antifungal activity (Bharathi et al., 2016).

Antioxidant activity

The oxidative damage in the biological system can be protected by the antioxidants. This antioxidant property was exhibited by the phenolic compounds of seagrass, and they have the ability to scavenge the free radicals. They also scavenge the reactive species such as superoxide radical (O_2^-), hydroxyl radical (OH), peroxide radical (ROO) and nitric oxide radicals (NO) (Santoso et al., 2012).

Thin-layer chromatography shows the strong antioxidant potential of seagrass such as *E.acoroides*, *Themprichii*, *H.pinifolia*, and *S isoetifolium*. The leaf extract of *E.acoroides* is rich in phenolic compounds compared to the rhizome and root with high antioxidant potential. The highest antioxidant activity is exhibited by methanolic extract in some seagrasses such as *Themprichii*, *C.roundata*, and *E.acoroides*. High value of

Table 2: Phytochemical analysis of Seagrass *Syringodium isoetifolium* with the Methanol, Acetone and Hexane Extraction

S.No	Phytoconstituents	Met	Ace	Hex
1	Alkaloids	-	-	+
2	Carbohydrate	+	+	+
3	Carboxylic acids	-	-	-
4	Cardiac glycosides	-	+	-
5	Coumarins	+	+	-
6	Flavanoids	+	-	+
7	Phenol	+	-	-
8	Phytosteroids	-	-	-
9	Proteins& aminoacids	-	+	+
10	Quinones	-	-	-
11	Saponins	+	-	-
12	Sugar	+	+	+
13	Tannin	+	-	-
14	Terpenoids	-	+	-
15	Xanthoproteins	-	-	-

Met: Methane, Ace: Acetone, Hex: Hexane, + = Present, - = Absent (Karthik et al., 2013)

ethyl acetate extract was seen in *S.isoetifolium*. *C.rotundata* and *H.uninervis*, which exhibits a free radical scavenging activity (Jeyapragash et al., 2016). The enzyme such as catalase, glutathione peroxidase, and superoxide dismutase acts an antioxidant defences and an increased level of oxidative stress markers (Sureda et al., 2008).

Antifungal activity

Seagrass acts as an antifungal agent that inhibits the growth of pathogenic fungi. And the immediate response was released to fungal infection due to the H₂O₂ was released. This seagrass only has the ability to release these H₂O₂ (Ross et al., 2008). *S.isoetifolium* shows an inhibitory effect against silkworm pathogens. The extract of *Syringodium isoetifolium* acts as an agent for saprophytic infection of silkworms based on their inhibitory and fungicidal action (Kumar et al., 2009).

Antibacterial activity

Seagrass has the highest value of soluble phenolic content, which exhibit multiple bioactive roles against pathogenic microorganisms. The extract of *Syringodium isoetifolium* was assessed for antibacterial assay by using the standard agar diffusion method.

The result shows that the methanol and ethanol extract of *S.isoetifolium* has maximum antimicrobial activity against *E.coli*. The growth of species such as *Pseudomonas aeruginosa*, *Bacillus cereus*, *Salmonella enteritidis*, *Staphylococcus aureus* was inhibited by extracts of *S.isoetifolium* (Mayavu et al.,

2009).

Cytotoxicity and Hemolytic activity

The cytotoxic activity of seagrass extract, *Syringodium isoetifolium* exhibit lesser toxicity with an LC₅₀ value of 699.096 µg/ml. *H.pinifolia* shows the minimum cytotoxic activity and hemolytic activity (2.07 ± 0.63% at 1000 µg/ml concentration) which was revealed by the nauplii of *Artemia salina*. These values may vary with respect to species to species (Rengasamy et al., 2013).

Antifouling activity

Syringodium isoetifolium inhibits the growth of biofilm bacteria and microalgae by showing the antifouling activity with its methanolic extract. It shows better MIC values than the *Enhalus acoroides*. The methanolic extract of *S.isoetifolium* shows low cytotoxic activity. By the GC-MS analysis, it shows 10 lipidic metabolites (Iyapparaj et al., 2014).

Against Fish Pathogens

Syringodium isoetifolium shows inhibitory activity against fish pathogens. Both gram-positive and gram-negative bacteria show an inhibitory effect on the methanolic extract of *Syringodium isoetifolium*. The Phytochemical constituent present in the extract of *Syringodium isoetifolium* shows more sensitivity against fish pathogens (Ravikumar et al., 2011).

Nanotechnology

Silver nanoparticles (AgNPs)

Stable silver nanoparticles can be synthesized by *Syringodium isoetifolium*. The analysis such as UV-VIS, XRD, FESEM, HRTEM, EDX, and AFM confirm the presence of AgNPs and the proteins acts as a reducing and capping agent. Bacteria, fungi, yeast, plants, and algae are capable of synthesizing AgNPs.

The report says that nanoparticles exhibits the antibacterial, anticancer, antiviral and show excellent catalytic activity. Diabetes-related complications and wound healing process were also treated by the use of silver nanoparticles (Ahila et al., 2016).

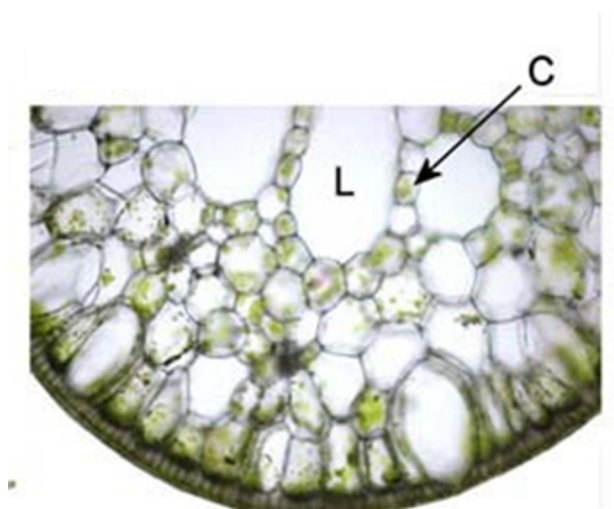


Figure 3: Cross section of *Syringodium isoetifolium*

Lacunal gas discharge

The lacunal gas is discharged through lacunae (Figure 3) during photosynthesis, which was composed of oxygen (32.5%) and nitrogen (67.5%). This method of photosynthetic fixation of carbon is very sensitive and simple (Borum et al., 2016). The rate of photosynthesis is directly proportional to the rate of discharge (Roberts and Moriarty, 1987).

Pheophytin

Pheophytin a compound was isolated from crude extract of *Syringodium isoetifolium* by treating it with the human pathogen, and the mode of action of the study explains about the active compound by *insilico* study. UV/VIS, Spectroscopy RP-HPLC, FT-IR, ESI-Mass' and ^1H and ^{13}C NMRs methods analyzes the potent fraction b and hydrate the compound pheophytin a ($\text{C}_{55}\text{H}_{74}\text{N}_4\text{O}_6$). Isolated pheo compound had MIC values of 6.2 ± 0.7 and 12.5 ± 0.8 for (*Salmonella typhi*, *Escherichia coli*, and *Pseudomonas aeruginosa*) $\mu\text{g ml}^{-1}$. The binding sites on the pathogens were studied by using (molecular docking study) Molegro Virtual Docker platform. UmuC proteins binds to five amino acid residues which was targeted by pheo compounds with inter-

action energy of -3.66 . Hence, pheophytin compound acts as an antibacterial agent against human pathogens (Sathyanathan et al., 2016).

CONCLUSIONS

From this study, we conclude that *Syringodium isoetifolium* has a compound pheophytin a, which was isolated by *insilico* study. It acts as an antibacterial agent against human pathogens. A Pheo-based natural product used for antibiotic therapies. *Syringodium isoetifolium* seagrass develops eighteen polymorphic loci, and the sequence is made by using SMRT technology. Pheophytin a, from *Syringodium isoetifolium* is used as a human translocator protein. A cell line study was also made, *invitro* to examine its effects on cell migration, DNA, cell cycle, and gene expression. The nature of the compound and target binding was found by *the insilico* study. In the future, the other compounds present in *Syringodium isoetifolium* can be determined and analyzed its pharmacological activities. The appreciable antibacterial activity can be seen against the gram-positive and gram-negative human and fish pathogens, when it is treated with the crude extract of *Syringodium isoetifolium*.

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