Prof. Suhara Beevy S.
Dr. Mariamma Cherian
Dr. Darsan B. Menon
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Dr. Mini V.S.

Trends in Advanced Biology

TRENDS IN ADVANCED BIOLOGY

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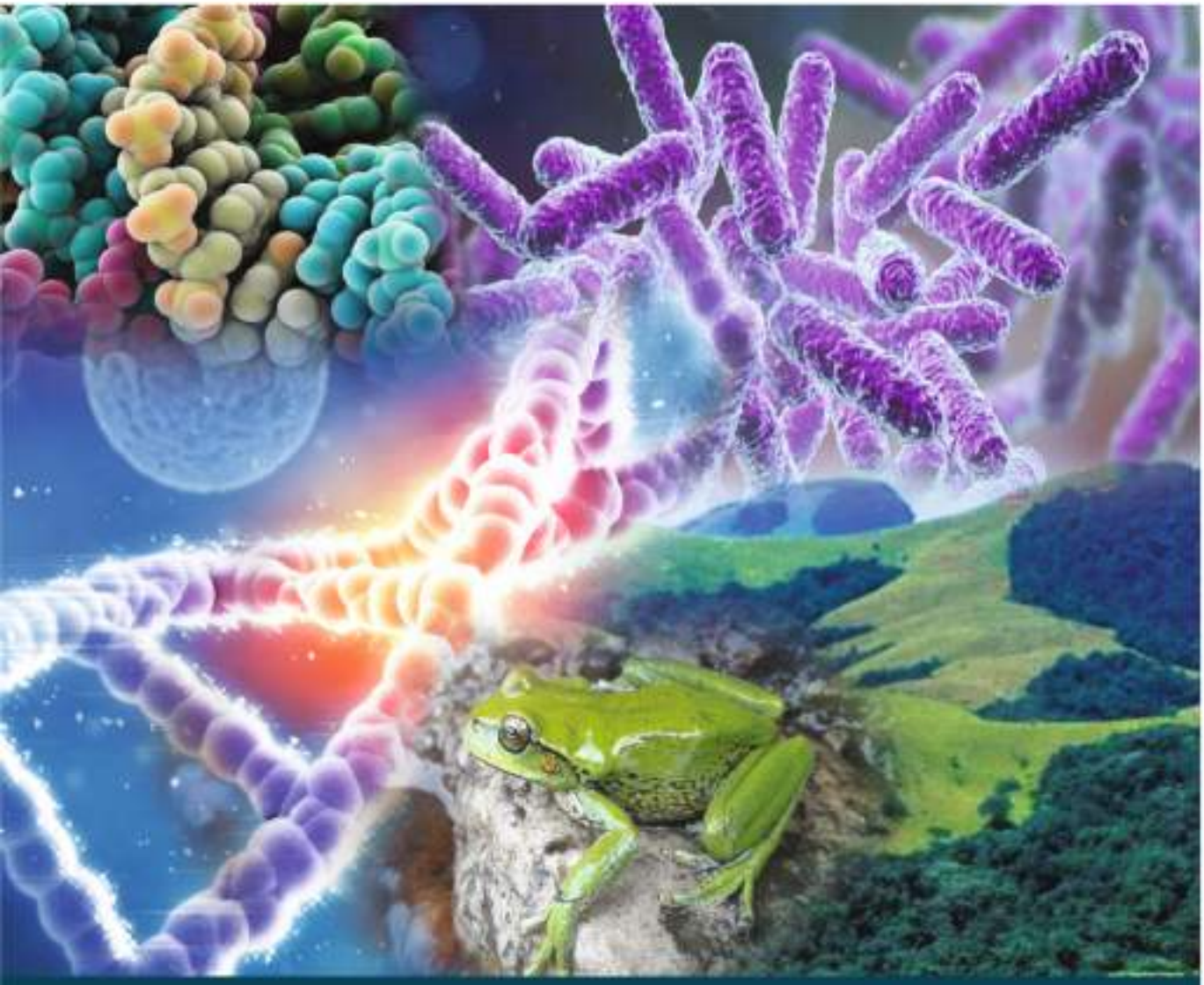

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Editors
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Dr. Anil Kumar T. R.

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PREFACE

'Trends in Advanced Biology', an edited volume, contains innovative research articles at the intersection of life sciences where integrative and emerging fields of investigations go hand in hand. The book edited by the team iCEIB, is a collection of about 50 research articles presented in a 3-day international webinar conducted by the Inter University Centre for Evolutionary and Integrative Biology to focus on the themes stress physiology, disease biology, environmental biology and biodiversity conservation. The articles envisage the role of advanced techniques such as genomics and proteomics in disease biology, role of abiotic and biotic factors that act upon organisms including plants and animals, and preservation of the diversity of species as well as sustainable utilization of species and ecosystem. Biodiversity, global climate change and food insecurity are the three major challenges before the humanity, with climate change appearing to escalate faster than the others. Therefore, the sustainable development path for future should essentially balance the economic development and natural resource conservation by suitable green technologies and innovations. The centre explores biological sciences in an innovative way using trans disciplinary approaches to pursue teaching and research in the various areas of modern biology. We provide research and teaching programs ranging from evolutionary structure and functions of various life forms to advanced studies on molecular technologies. In this Book, 'Trends in Advanced Biology" an attempt has been made to extract all the afore mentioned key information and ideas from different sources and discuss the current state of knowledge in biology. We have largely derived the core content of this book from the ideas and research outputs from various reputed scientists who have contributed immensely on various aspects of Advanced Biology. All this information and expertise of researchers with suitable illustrations are compiled in this book. Undoubtedly this book covers a huge range of advanced techniques such as genomics and proteomics in life sciences, how plants and animals responds to stress by using adaptations that help them evade, tolerate, or recover from stress, biodiversity documentation, conservation measures, and strategies which are useful to sustainability of environment. The editors are grateful to the authors for preparing excellent contributions and strongly supporting our efforts to put up comprehensive information in this book. We also place on record our sincere gratitude to the University of Kerala for the financial support to accomplish this.

Director,
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A review on bioactive potential of two seagrasses *Cymodocea serrulata* and *Syringodium isoetifolium*

M. Hazeena Ameen[1] and Ayona Jayadev*
Postgraduate Department of Environmental Sciences, All Saints' College, Thiruvananthapuram, 695007 Kerala, India.
* ayona.evs@allsaintscollege.ac.in

Abstract

The marine realm occupies 71% of the earth's surface and is a critical ecosystem in the planet, providing us with oxygen, food, and a means of livelihood. When compared to other marine ecosystems, seagrasses are the principal producer where most fishes feed and they also serve an essential role in supporting marine coastal species and human livelihood. Seagrass secondary metabolites have a wide range of bioactivity, including anticancer, antibacterial, antifungal, antioxidant, and antimacrofouling properties. The bioactive potential of two seagrasses, *Cymodocea serrulata* and *Syringodium isoetifolium*, is discussed in this review. Both these seagrasses come under same family Cymodoceaceae also known as 'manatee-grass family'. *C. serrulata* is found in clear waters and in high intertidal areas of Indian Ocean, Red Sea, South China Sea and Pacific Ocean. *S. isoetifolium* forms meadows in shallow sandy or muddy waters in the Indian and Pacific Oceans. This review gives an idea of the biological insights of both seagrasses in detail.

Keywords: Seagrasses, bioprospecting, bioactive compounds, *Cymodocea serrulata*, *Syringodium isoetifolium*

1. Introduction

Marine ecosystems are the world's largest and most stable ecosystems, and they play a critical role in the environment. Seagrasses are an important aspect of the marine environment because they provide food, habitat, and nursery regions for a variety of vertebrate and invertebrate species. Seagrass meadows provide essential ecological services such as nutrient cycling, greater biodiversity, and carbon sequestration and coastal protection, all of which contribute to climate change mitigation and adaptation. According to reports, marine plants and animals have a diverse range of bioactive compounds that are structurally unique and biologically active. In recent years, research in the field of marine natural products has increased significantly (Devi *et al*., 1997).Antimicrobial medication usage, particularly over use of

antibiotics, is a rising source of concern not only in human medicine and agriculture, but also in aquaculture. As a result, the urgent need is to find antibiotics with unique properties to which organisms may not have acquired resistance, and the quest for novel antibiotics is a never-ending process (Gumgumjee, *et al*., 2018).Seagrasses serves as a potent marine source for many natural products which can also be used for pharmaceutical manufacture in addition to their environmental benefits. They are monocotyledonous plants that belong to four families: *Posidoniaceae, Zosteraceae, Hydrocharitaceae*, and *Cymodoceaceae* and it includes about 72 species. This review focuses at the bioactive potential of two seagrasses, *Cymodocea serrulata* and *Syringodium isoetifolium*. Both of these seagrasses belong to the *Cymodoceaceae* family.

1.1 Family Cymodoceaceae- An overview

Cymodoceaceae is a flowering plant family that includes only marine species and is also referred to as the "manatee-grass family" (Waycott *et al*., 2014). It includes five genera- *Amphibolis* - 2 species (*A. antarctica, A. griffithii)*, *Cymodocea* - 4 species (*C.angustata, C. nodosa, C. rotundata, C. serrulata*), *Halodule* - 7 species (*H. beaudettei, H. bermudensis, H. ciliate, H. emarginata, H. pinifolia, H. uninervis, H. wrightii*), *Syringodium* - 2 species (*S. filiforme, S. isoetifolium*), and *Thalassodendron* - 3 species (*T. ciliatum, T.leptocaule, T. pachyrhizum*) (Duarte *et al*., 2012).

Cymodocea serrulata: - Commonly known as serrated ribbon grass. It is found throughout the tropical Indo-West Pacific and is most commonly seen on muddy reef tops. As a result of natural succession, it swiftly grows over *Halophila* beds.

Syringodium isoetifolium: - It is known as noodle grass. It forms meadows in shallow sandy or muddy waters in the Indian and Pacific Oceans. *S. isoetifolium* has long spaghetti-like leaves that may obtain nutrients and gas through a thin cuticle but lack stomata (Bharathi *et al.*, 2016).

Fig. I. Images of *C. serrulata* and *S. isoetifolium*

1.2. Secondary metabolites from *C. serrulata* and *S. isoetifolium*

Compounds such as campesterol, isofucosterol, p-Hydroxybenzoic acid, protocatechuic acid, vanillic acid, gallic acid, gentisic acid, coumaric acid, caffeic acid, and ferulic acid were reported from *C. serrulata* during different researches (Gillan *et al*.,1984; Zidorn, 2016). *S. isoetifolium* contains phenolic acids as p-coumaric acid, caffeic acid, ferulic acid, protocatechuic acid, p-hydroxybenzoic acid, vanillic acid, gentisic acid, and gallic acid (Zapata and Mcmillan, 1979).

1.3. Bioactivity of *C. serrulata* and *S. isoetifolium*

Recent study has increased the hunt for new sea grass compounds, which include high levels of antioxidants such as polyphenols, terpenoids, flavonoids, tannins, and saponins for human welfare (Ansari and Ghanem, 2019). The antibacterial, anti-inflammatory, anti-cancer, anti-viral, anti-oxidant, and tranquillizer characteristics of both sea grasses, *C. serrulata* and *S. isoetifolium,* as well as their prospective applications, are discussed in the following section.

The antibacterial activity of *S. isoetifolium* extracts in various organic solvents revealed that methanol extract exhibited a wider spectrum range of growth inhibitory actions than chloroform and acetone extracts (Shyamalagowri *et al*., 2021). *Pseudomonas aeruginosa, Bacillus cereus, Salmonella enteritidis*, and *Staphylococcus aureus* were all inhibited by *S. isoetifolium* extracts (Mayavu *et al*., 2009).*C. serrulata* ethanol extract has the highest free radical scavenging activity and includes a large amount of total phenols and flavonoids; therefore, it has good antioxidant qualities and can be used to treat a range of free radical-mediated disorders (Bharathi *et al*., 2019). *C. serrulata* is a valuable bioresource for generating rapid and eco-friendly bioactive silver nanoparticles (AgNPs) for cancer therapy, according to a study conducted on green

synthesis of bioactive silver nanoparticles (AgNPs) under different temperatures using the aqueous extract of seagrass *C. serrulata* (Palaniappan *et al*., 2015). The *C. serrulata* mediated AgNPs should be considered a significant biocontrolling agent that can be researched further in the direction of drug development, because the synthesised AgNPs showed preponderant *in vitro* cytotoxicity against HeLa cells indicating that they should be investigated further in the direction of human cancer therapy development (Chanthini *et al*., 2015). Table I summarizes the bioactivity of both seagrasses *C. serrulata* and *S. isoetifolium.*

Table I. Bioactive potential of *C. serrulata* and *S. isoetifolium*

Extract	**Seagrass species**	**Biological activity**	**Reference**
Hexane, chloroform, methanol	*C.serrulata*	Antibacterial	Kannan *et al.*, 2010
Hexane, chloroform	*C. serrulata*	Antibacterial	Kannan *et al.*, 2010
Chloroform, ethyl acetate, ethanol and hexane	*C. serrulata,*	Antimicrobial	Sangeetha & Asokan, 2015
Ethanol, methanol extract	*C. serrulata*	Antimicrobial	Prabhakaran *et al*., 2012
Aqueous ethanol	*S. isoetifolium, C. serrulata*	Larvicidal	Ali *et al*., 2012
Aqueous methanol	*S. isoetifolium*	Antioxidant and haemolytic activity	Kannan *et al*., 2010
Methanol extract	*S. isoetifolium, C. serrulata*	Antioxidant	Athiperumalsami *et al*., 2008
Ethanol extract	*S. isoetifolium, C. serrulata,*	Antioxidant	Kannan *et al*., 2012
Methanol, ethyl acetate, hexane	*S. isoetifolium*	Antioxidant	Santoso *et al*., 2012
Methanol, acetone hexane	*S isoetifolium*	Antioxidant	Girija *et al*., 2013
Ethanol	*C. serrulata*	Antioxidant	Bharathi *et al*., 2019
Methanol	*S. isoetifolium*	Antioxidant	Bharatharathna & Santhanam, (2019)

Ethanol	*C. serrulata, S. isoetifolium*	Nutritional supplements	Vijayalingam & Rajesh, 2019
Hydroalcoholic	*S. isoetifolium*	Antibacterial, antifungal, antimicrobial, antifouling and anticancerous	Kalaivani & Amudha, 2021
Methanol	*S. isoetifolium*	Antibacterial	Shyamalagowry *et al*., 2021

2. Conclusion

This review gives a brief outline of both the seagrasses *C. serrulata* and *S. isoetifolium* and their metabolites with remarkable nutritional and bioactive potential, such as antioxidants, antimicrobials, and anticancer agents, according to this analysis. A review of the existing bioactivity investigations suggests that both seagrasses have the potential to be used to treat cancer, AIDS, inflammatory disorders, arthritis, malaria, and a variety of viral, bacterial, and fungal illnesses. Despite the fact that researchers are attempting to identify, separate, and characterize anti-microbial compounds from seagrasses, which will benefit human existence on Earth, more effort is needed to identify, isolate, and quantify potential compounds from seagrasses.

References

Ali, M. S., Ravikumar, S., & Beula, J. M. (2012). Bioactivity of seagrass against the dengue fever mosquito Aedes aegypti larvae. *Asian Pacific Journal of Tropical Biomedicine*, *2*(7), 570- 573.

Ansari, A. A., & Ghanem, S. M. (2019). Growth attributes and biochemical composition of *Padina pavonica* (L.) from the Red Sea, in response to seasonal alterations of Tabuk, Saudi Arabia. *The Egyptian Journal of Aquatic Research*, 45(2), 139-144.

Athiperumalsami, T., Kumar, V., & Jesudass, L. L. (2008). Survey and phytochemical analysis of seagrasses in the Gulf of Mannar, southeast coast of India. https://doi.org/10.1515/BOT.2008.038

Bharatharathna, P., & Santhanam, P. (2019). Analyses of phytochemical, biochemical, pigments and antioxidant activity of seagrass *Syringodium isoetifolium*. *Journal of Advanced Scientific Research*, 10 (04 Suppl 2), 267-271.

Bharathi, N. P., Amudha, P., & Vanitha, V. (2016). Sea grasses—Novel marine nutraceuticals.

International Journal of Pharma and Bio Sciences, *7*(4), 86-94.

Bharathi, N. P., Jayalakshmi, M., Amudha, P., & Vanitha, V. (2019). Phytochemical screening and in vitro antioxidant activity of the seagrass *Cymodocea serrulata*. *Indian Journal of Marine Sciences*, 48(8), 1216-1221. WOS:000498626400008

Chanthini, A. B., Balasubramani, G., Ramkumar, R., Sowmiya, R., Balakumaran, M. D., Kalaichelvan, P. T., & Perumal, P. (2015). Structural characterization, antioxidant and in vitro cytotoxic properties of seagrass, *Cymodocea serrulata* (R. Br.) Asch. & Magnus mediated silver nanoparticles. *Journal of Photochemistry and Photobiology B: Biology*, *153*, 145-152.

Devi, P., Solimabi, W., D'Souza, L., Sonak, S., Kamat, S. Y., & Singbal, S. Y. S. (1997). Screening of some marine plants for activity against marine fouling bacteria. *Botanica Marina*, *40*, 87-91.

Duarte, M. C., Bandeira, S., & Romeiras, M. M. (2012). Systematics and ecology of a new species of seagrass (*Thalassodendron, Cymodoceaceae*) from southeast African coasts. *Novon: A Journal for Botanical Nomenclature*, *22*(1), 16-24.

Gillan, F. T., Hogg, R. W., & Drew, E. A. (1984). The sterol and fatty acid compositions of seven tropical seagrasses from North Queensland, Australia. *Phytochemistry*, *23*(12), 2817-2821.

Girija, K., Parthiban, C., Hemalatha, A., Saranya, C., & Anantharaman, P. (2013). Evaluation of antioxidant activities and preliminary phytochemical analysis of seagrasses *Halodule pinifolia, Halophila ovalis* and *Syringodium isoetifolium*. *The Journal of Phytochemistry*, *114*, 181-187.

Gumgumjee, N. M., Bukhari, D. A., Alshehri, W. A., & Hajar, A. S. (2018). Antibacterial activity of *Halodule uninervis* leaves extracts against some bacterial pathogen strains. *Pharmacophore*, *9*(2), 52-59.

Kalaivani, P., & Amudha, P. (2021). Identification of bioactive components in the hydroalcoholic extract of *Syringodium Isoetifolium* and assessment of its biological activity by gas chromatography–masspectrometry. *International Journal of Research in Pharmaceutical Sciences*, *12*(2), 1168-1173.

Kannan, R. R. R., Arumugam, R., & Anantharaman, P. (2010). Antibacterial potential of three seagrasses against human pathogens. *Asian Pacific Journal of Tropical Medicine*, *3*(11), 890-893.

Kannan, R. R. R., Arumugam, R., & Anantharaman, P. (2012). Chemical composition and antibacterial activity of Indian seagrasses against urinary tract pathogens. *Food Chemistry*, *135*(4), 2470-2473.

Mayavu, P., Sugesh, S., & Ravindran, V. J. (2009). Antibacterial activity of seagrass species against biofilm forming bacteria. *Research Journal of Microbiology*, *4*(8), 314-319.

Palaniappan, P., Sathishkumar, G., & Sankar, R. (2015). Fabrication of nano-silver particles using *Cymodocea serrulata* and its cytotoxicity effect against human lung cancer A549 cells line. *Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy*, *138*, 885-890.

Prabhakaran, S., Rajaram, R., Balasubramanian, V., & Mathivanan, K. (2012). Antifouling potentials of extracts from seaweeds, seagrasses and mangroves against primary biofilm forming bacteria. *Asian Pacific Journal of Tropical Biomedicine*, *2*(1), S316-S322.

Sangeetha, J., & Asokan, S. (2015). Antibacterial activity of different sea grass Extracts against some human eye pathogens. *World Journal of Pharmaceutical Sciences*, *4*(12), 677-683.

Santoso, J., Anwariyah, S., Rumiantin, R. O., Putri, A. P., Ukhty, N., & Yoshie-Stark, Y. (2012). Phenol content, antioxidant activity and fibers profile of four tropical seagrasses from Indonesia. *Journal of Coastal Development*, *15*(2), 189-196.

Shyamalagowri, S., Devi, S., Shanthi, N., & Murugesan, S. (2021). Antibacterial Potential of Seagrass *Syringodium isoetifolium* (Ascherson) Dandy against human pathogens. *Research Journal of Agricultural Science*, *12*(6), 2180–2184

Vijayalingam, T., & Rajesh, N. V. (2019). Seagrasses as potential source of fodder for livestock: Complete proximate and gas chromatography-mass spectrometry (GCMS) analysis. *Annals of Phytomedicine*, *8*(2), 93-98.

Waycott, M., McMahon, K., & Lavery, P. (2014). *A guide to southern temperate seagrasses*. Csiro Publishing.

Zapata, O., & McMillan, C. (1979). Phenolic acids in seagrasses. *Aquatic Botany*, *7*, 307-317.

Zidorn, C. (2016). Secondary metabolites of seagrasses (Alismatales and Potamogetonales; Alismatidae): Chemical diversity, bioactivity, and ecological function. *Phytochemistry*, *124*, 5-28.