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A Review on *Halodule uninervis* – A Potent Seagrass

Leelarani Ravilla, Navaith Ahmed S, Kalaivani P, Vanitha V*

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

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ABSTRACT

*Halodule uninervis*is a flowering plant commonly known as needle seagrass. *Halodule uninervis* is widely distributed in the Indo-pacific region. In the Indian Ocean, it is found from Geographe Bay in Western Australia. It is a euryhaline species that can tolerate high salinity, grows, reproduce and complete their entire life cycle undersea at the submerged condition. *Halodule uninervis*was found to be rich in phenol and phenylpropanoid derivatives such as p-coumaric acid, caffeic acid, p-hydroxybenzoic acid and vanillic acids. As the seagrasses are known to produce unique secondary metabolites as a defense mechanism, many research was targeted towards them in order to search novel potent antioxidants or antibiotics. p-hydroxybenzoic acid acts as an intermediate for several bioproducts that are commercially valuable in food, cosmetics, pharmacy, fungicides, etc. Caffeic acid acts as a free radical scavenger. It has been found that caffeic acid phenyl ester inhibits DNA, RNA and protein synthesis in HL-60 cells; thus, it arrests the growth of human leukaemia cells. The western Pacific and Indian oceans are the indigenous origins of *Halodule uninervis*. Interesting the fact that *Halodule uninervis*is an important food for the green sea turtle and dugong and as well as it was used traditionally for wound ailments. These make the seagrass *Halodule uninervis* a potent plant that needs to be exposed. This review elaborates on the features and recent approaches of the seagrass *Halodule uninervis*.

*Corresponding Author

Name: Vanitha V
Phone: 9941709668
Email: vanitha.sls@velsuniv.ac.in

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INTRODUCTION

Nature is being stated to treat, protect and prevent many ailments. In the ancient medical system, naturally derived products have been an integral part. In India, there are many medicinal plants habituated are used as a treatment for various infectious diseases as well as to manage and cure the disorders. Not only the terrestrial plants were used as a medicine, the marine angiosperms also used as a remedy to treat fever, cardiac disease, malaria, cough, skin diseases, early stages of leprosy, and as a paste to treat wounds (Namadevan *et al.*, 2017). Marine angiosperms are the hydrophytes that grows completely submerged saline environment. They are called as seagrass as they resemble the family Poaceae. As they grow and complete their life cycle in a stress environment, they were rich in Phyto protectants that are unique and novel. These phytocompounds are secondary metabolites that can act as an antibacterial, antioxidant and can act as efficient nutraceuticals. There are a totally 14 species that are grown in southeast coastal regions of India in those predominantly seen are *Thalasssiahemprichii, Cymodocea serrulata, Cymodocearotundata, Halodule uninervis, Syringodium isoetifolium,*

Halophila beccarii, Halophila ovalis and Halophila ovata. Each seagrass is unique in their photo components (Newmaster *et al.*, 2011). This study elaborates the botanical features, morphology, phytocompounds and pharmacological aspects of Halodule uninervis. It is the main diet for dugongs and green turtles as it is rich in calorie and also their smaller leaf structure makes them to easily digest.

BOTANICAL DESCRIPTION

Seagrass is classified into four families; they are Hydrocharitaceae, Cymodoceaceae, Posidoniaceae, and Zosteraceae. *Halodule uninervis* belongs to the family Cymodoceaceae, which was evolved before 61 million years, called the manatee-grass family.

Taxonomy

Kingdom Plantae -plants

Subkingdom Tracheobionta - vascular plants

Super division Spermatophyta - seed plants

Division Magnoliophyta - flowering plants

Class Liliopsida

Subclass Alismatidae

Order Najadales

Family Cymodoceaceae

Genus Halodule

Species *Halodule uninervis*

Distribution

Halodule uninervis is widely distributed in the Indo-pacific region. In the Indian Ocean, it is found from Geographe Bay in Western Australia extends across the Timor Sea, the south coast of Indonesia, and to the Andaman Sea and extending around the Bay of Bengal and around India to the Malabar Coast. It ranges from the Persian Gulf to the Red Sea, south to the east coast of South Africa to Madagascar and the islands of the western Indian Ocean (Waycott *et al.*, 2004).

In the Pacific, it is found in southern Japan, Taiwan, the Philippines, Malaysia, Indonesia, throughout the Gulf of Thailand and along the coast of Vietnam and southern China. It occurs throughout insular Southeast Asia, northeast of the Northern Mariana Islands, Micronesia, and southeast of the Fiji Islands, as well as across northern Australia and the Great Barrier Reef. In Egypt, it is seen South Red Sea Coast, North Red Sea Coast, Arabian Desert, Galala Desert, Mountainous Southern Sinai. Globally, it is distributed as Egypt to Mozambique, South Africa, Madagascar, Mauritius, Seychelles, Arabia to the Philippines, Australia, New Caledonia (Short *et al.*, 2007).

HABITAT AND ECOLOGY

Halodule uninervis is a sublittoral seagrass found from the mid-intertidal to a depth of 20 m. *Halodule uninervis* can grow in a range of different habitats. It is very common between 0-3m in sublittoral lagoons and in front of the reefs. It is very fast-growing, colonizes rapidly and can flower prolifically. Some locations have very large seed banks. At some sites, it forms the dense meadows that may be as a single species or intermixed with other seagrass species (Skelton and South, 2006) and it is grown with large algae on a back reef (Jacobs and Dicks, 1985), Figure 1 represents the seagrass bed of *Halodule uninervis*. There is wide variation in leaf width, from 1.1-7 mm.

Figure 1: *Halodule uninervis* seagrass meadow under the sea

This species can withstand high salinity and can tolerate moderate disturbance and is ephemeral with rapid turn-over and high seed set. It is considered a pioneer species, growing rapidly and surviving well in unstable and depositional environments in Eastern Australia. It is also a pioneer species in Indonesia, usually forming monospecific beds on the inner reef flat or on steep sediment slopes in both the intertidal and subtidal zones and it has the highest density of all seagrass species in mixed (2,847 shoots/m) as well in monospecific beds (14,762 shoots/m). In Thailand, it grows in sandy or muddy sand substrates from the upper littoral to subtidal areas. This is the principal seagrass species in Kuwait and extends along the coast of Saudi Arabia. In the Arabian Gulf, it tolerates extreme conditions with salinity varying from 38-70 ppt and temperatures of 1039C at inshore and at offshore 19-33C (Green and Short, 2003). It is one of the favored foods of the Dugong and often heavily grazed (Lip-

kin, 1975).

Morphology

Morphology of *Halodule uninervis*superficially resembles the terrestrial grass belongs to the family Poaceae as they have long narrow leaves often form large meadows by extending their rhizome. *Halodule uninervis* is a thin, flat needle-like seagrass, a perennial flowering plant that grows up to 2-4.5cm with the erect and wiry stem (West *et al.*, 1998).

Root

Halodule uninervis has very fine roots at the rhizome about 1-6 roots and a short erect stem at each node. It has a fibrous root, which extends by rhizome and forms an extensive meadow.

Leaves

About 2-4 leaves emerge alternatively on a short erect stem. Leaves have a more persistent sturdy leaf sheath about 1-3.5 cm long, which are long, folded, biauriculate and ligulate.

The leaf blades are narrow-linear, flat grows straight to 6-15cm long and 0.25-5mm wide. The apex of the leaf is 3- toothed with a dark green prominent midrib. Leaves contain three parallel veins which are distinct. Figure 2 represents the veins of *Halodule uninervis* (Keng *et al.*, 1998).

Figure 2: The leaf of *Halodule uninervis*

Flowers and fruits

Halodule uninervis is a dioecious plant that has a separate male and female flower as a reproductive part. Flowers were tiny and grown at the base of the leaf sheath; male flowers are borne on a short peduncle and are enclosed in a leaf. They have a tiny red anther. The flowers are solitary and terminal, buried in the sediment emerges only for a short period.

Seeds are produced with a hard seed coat and it is released directly into the sediments so that they are not washed by currents. This unusual habit of *Halodule uninervis* helps it to reestablish them when parent plants are destroyed (Jupp *et al.*, 1996).

Phytocompounds

Generally, seagrass is rich in phenolic substances as they undergo stress. These secondary metabolites act as photoprotectants responsible for self-defense against pathogens. Such compounds are flavones, condensed tannins, phenolic acids, sulphated phenolic acid and lignin are prominently seen in seagrass than the terrestrial plants. It has been evaluated that the total phenolic content of *Halodule uninervis* rhizome is 14.96±0.47mg and its leaf is 13.77±0.79mg GAE/g extract, which is significant. *Halodule uninervis*was found to be rich in phenol and phenylpropanoid derivatives such as p-coumaric acid, caffeic acid, p-hydroxybenzoic acid and vanillic acids (Subhashini *et al.*, 2013).

p-coumaric acid is a precursor for flavonoids. It was shown to reduce oxidative stress, inhibits genotoxicity and exerts neuroprotection. In the treatment of dementia by scopolamine induce learning and memory impairment, but on cotreating, with p coumaric acid it improves the avoidance memory and long-term retention of spatial memory (Kim *et al.*, 2017). p-coumaric acid, bioactive flavonoids, possess a specific anabolic effect on bone. It is found that it stimulates osteoblastogenesis and inhibits osteoclastogenesis (Yamaguchi *et al.*, 2013). It has been demonstrated that the administration of p-coumaric acid on ovariectomy-induced bone loss rats restored the calcium content in the femoral diaphyseal and metaphyseal tissues. Thus p-coumaric acid possesses a preventive effect on bone loss in ovariectomy rats (Yamaguchi *et al.*, 2008).

Caffeic acid acts as a free radical scavenger. It has been found that caffeic acid phenyl ester inhibits DNA, RNA and protein synthesis in HL-60 cells; thus, it arrests the growth of human leukaemia cells (Chen *et al.*, 1996). p-hydroxybenzoic acid acts as an intermediate for several bioproducts that are commercially valuable in food, cosmetics, pharmacy, fungicides, etc. It is a precursor for the production of reseveratrol, muconic acid, gentrodin, xiamenmycin and vanillyl alcohol, which are industrially pertinent (Wang *et al.*, 2018). Vanillic acid is a flavouring agent in some foods. It is a byproduct of caffeic acid.

Nutritional value

Halodule uninervis is mostly preferred food for sea dungeons. It is maybe due to needle-shaped leaves, which are easy to digest, or it is maybe due to its

high calorific value, which makes them store energy for the longest time. The complete phytochemical analysis of *Halodule uninervis* shows the presence of carbohydrate, protein, lipid, tannin and phenol, cardiac alkaloids, flavones, glucosides, saponins, palmitic acid, linoleic acid, phenylethanederivative, (S)-methoxy-(3-,5-dimethoxy-4-hydroxyphenyl) ethanediol, 3,4,5-trihydroxy benzoic acid, (E)-3-(4-methoxyphenyl)-2-propenoic acid, syringin (7), 5-hydroxy-3-4 7-trimethoxyflavone, and 4'-hydroxy-3',5,7-trimethoxy flavones (Kannan *et al.*, 2010). The calorific value of *Halodule uninervis* leaves is determined to be 40.15 kcal g-1 and its rhizomes to be 37.16 kcal g-1. There is a higher content of protein and carbohydrate in rhizomes than the leaves. This suggests that the seagrass *Halodule uninervis* stores its soluble carbohydrates and protein in the rhizomes and shoots and mobilized for plant growth (Dhawan *et al.*, 1977).

RECENT APPROACHES

On the basis of its traditional uses, *Halodule uninervis* was tested against STZ induced diabetic rats. The methanolic extract of *Halodule uninervis* was efficient at 150 and 250 mg/kg of body weight. It lowers the blood glucose level after the 18^{th}day of administration. Thus, this study reveals the potential of *Halodule uninervis* to act as an antidiabetic agent and justify the traditional use of this as the medicinal herb (Karthikeyan and Sundarapandian, 2017).

The study of methanol extract of *Halodule uninervis* on scavenging free radicals proves it to possess antioxidant activity. DPPH scavenging assay of *Halodule uninervis* showed that its IC50 1.575ppm and reducing power assay to be IC_{50} 1.381, which was efficient (Baehaki *et al.*, 2016). The comparative antioxidant study on six seagrass species such as *Halodule uninervis* (Forsk.) Asch., *Syringodium isoetifolium*(Asch.) Dandy, *Cymodocea rotundata*Ehrenb. &Hempr. Ex Asch.,*Thalassia hemprichii*(Ehrenb.) Asch., *Enhalusacoroides*(L.F.) Royle and *Halophila ovata*Gaud results in maximum phenolic content and antioxidant activity exhibited by *Cymodocea rotundata*, followed by Halodule uninervis. It showed that the *Halodule uninervis* rhizome had a higher reducing power of 0.557 ± 0.03, it may be due to the unique ability of *Halodule uninervis* to convert ferrous ion radical into a reduced form (Jeyapragash *et al.*, 2016). When methanol extract of *Halodule uninervis* tested against gram-negative bacteria (*Aeromonashydrophila and Vibrio harveyi*) and gram-positive bacteria (*Bacillus subtilis and Listeria monocytogenes*) it shows higher inhibitory activity against gram-positive bacteria. The zone of inhibition is about 7mm to 9mm. This shows that the *Halodule uninervis* extract can serve as a good antibiotic against gram-positive pathogens (Supriadi *et al.*, 2016).

CONCLUSIONS

The presence of unique secondary metabolites in *Halodule uninervis* makes them valuable as it can be widely applied as an antioxidant, especially in food preserving industries-in preserving food decay from lipid peroxidation as well as in treating various diseases caused due to free radicals. It can also act as antimicrobial, which paves the way to the production of novel antibiotic that is susceptible to various pathogens. Thus*Halodule uninervis*, which is a potent plant that has been hidden undersea, needed further research to explore them as an efficient medicinal plant.

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