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Review On The Ecological Significance, Diversity, And Utilization Of Salt Marsh Plants

[1]R. Sasiram, [2]Dr. D. Linga Prabhu, [3]Dr. D. Pradeepa

[1]Student, [2]Scientist ICAR – CMFRI, [3]Associate professor

[1]M.Sc Biochemistry ,

[1]Dr. N.G.P Arts and Science college, Coimbatore, India

ABSTRACT:

Salt marshes are highly productive coastal ecosystems that play a crucial role in biodiversity conservation, carbon sequestration, and shoreline stabilization. These ecosystems support a diverse range of halophytic plant species that have adapted to saline and waterlogged conditions. Salt marsh plants contribute significantly to ecosystem functioning by providing habitat for wildlife, improving water quality, and mitigating climate change through carbon storage. Their ecological significance extends to nutrient cycling, erosion control, and serving as natural barriers against storm surges and coastal flooding. The diversity of salt marsh vegetation varies across geographical regions, influenced by factors such as salinity gradients, tidal regimes, and climatic conditions. Dominant plant species include *Spartina* spp., *Salicornia* spp., and *Juncus* spp., each possessing unique physiological and morphological adaptations to withstand high salinity and periodic inundation. The biodiversity within salt marshes supports various trophic interactions, including those involving primary producers, herbivores, and decomposers. Beyond their ecological importance, salt marsh plants have significant utilization potential in various fields, including agriculture, medicine, and biotechnology. Some species exhibit bioactive properties with antimicrobial, antioxidant, and anti-inflammatory activities, making them valuable for pharmaceutical applications. Additionally, their use in soil remediation and biofuel production highlights their economic potential. However, salt marsh ecosystems face increasing threats from climate change, habitat destruction, and anthropogenic pollution, necessitating conservation and sustainable management efforts. This review provides a comprehensive overview of the ecological significance, diversity, and utilization of salt marsh plants, emphasizing their role in ecosystem stability and their potential applications in various industries.

Keywords: Salt marsh plants, halophytes, biodiversity, carbon sequestration, ecosystem services, climate change, bioactive compounds, habitat conservation, soil remediation, coastal ecosystems.

INTRODUCTION:

Coastal wetlands known as salt marshes are located in intertidal zones, where they are subject to tidal inundation on occasion and changing salinity levels. These ecosystems are extremely productive and offer vital functions like water filtering, coastline stabilisation, and wildlife habitat(Adam, 1990).Halophytes, or salt marsh plants, have evolved certain physiological and structural characteristics that enable them to withstand high salinity, waterlogging, and low soil oxygen levels in order to live in these hostile environments(Mitsch & Gosselink, 2015).

Depending on how exposed they are to tidal flooding, salt marsh vegetation is divided into low and high marsh plants. While high marsh species like Salicornia europaea (glasswort) and Distichlis spicata (saltgrass) are located in less often inundated zones, low marsh species like Spartina alterniflora (smooth cordgrass) flourish in places that are regularly submerged by seawater(Flowers & Colmer, 2008).These plants have developed a

number of adaptations, including systems for excreting salt, succulent tissues that retain water, and specialised root structures that enable them to obtain oxygen in soil that has been flooded(Barbier et al., 2011).
Beyond their ecological significance, salt marsh plants are essential for reducing the effects of climate change because they operate as carbon sinks, storing significant amounts of atmospheric carbon in their sediments and biomass. Additionally, by lessening the effects of storm surges and halting erosion, they enhance coastal resiliency(Mitsch & Gosselink, 2015).To save these priceless ecosystems from dangers like pollution, habitat loss, and sea level rise, conservation and restoration initiatives are essential.

DIVERSITY:
A wide variety of plant species that are acclimated to varying salinity, tidal flooding, and soils lacking oxygen can be found in salt marshes. Regional variations in the composition of salt marsh vegetation are caused by environmental factors as climate, sediment type, and hydrology(Pennings &Bertness, 2001).In salt marshes, plant diversity is essential for stabilising sediments, supplying wildlife habitat, and raising ecosystem productivity overall(Neckles & Dionne, 2000).
Plants found in salt marshes can be divided into groups according on how well they withstand flooding and salinity. Spartina alterniflora (smooth cordgrass) in North America and Spartina maritima in Europe are prominent species in low marshes, where plants frequently undergo tidal submersion. These plants have specialised adaptations such salt-excreting glands that assist control internal salinity levels and aerenchyma tissue that makes it easier for oxygen to reach submerged roots(Burdick & Mendelssohn, 1990).
More plant diversity is found in the high marsh, which floods less regularly. These regions are home to species like Batis maritima (saltwort), Limonium carolinianum (sea lavender), and Salicornia virginica (pickleweed). While some high marsh plants grow deep root systems to obtain freshwater, many are succulents that store water in their tissues to combat extreme salinity(Bertness, 1991).The plant variety of salt marsh environments is further increased by certain facultative halophytes that can withstand both freshwater and saltwater conditions(Pennings et al., 2005).
Globally, the diversity of salt marsh plants varies according to tidal forces and climatic circumstances. While tropical and subtropical marshes may contain species like Sarcocornia perennis (perennial glasswort) and Sesuviumportulacastrum (sea purslane), temperate salt marshes are typically dominated by grasses and rushes(Adam, 2002).Furthermore, the microbial populations linked to salt marsh plants support the breakdown of organic matter and the cycling of nutrients, which enhance ecosystem functioning(Ravit et al., 2003).
The diversity of salt marsh plants is endangered by pollution, sea level rise, and habitat loss, despite their ecological importance. For these ecosystems to remain resilient over the long term and preserve biodiversity, restoration initiatives—such as replanting native species and managing invasive plants—are essential(Zedler & Kercher, 2005).

RESOURCE AVAILABILITY OF SALT MARSH PLANTS: GLOBAL AND INDIA:
With notable differences in plant species composition and resource availability depending on geographic and climatic conditions, salt marshes are found along coastlines all over the world. Around the world, salt marshes can be found in tropical, subtropical, and temperate climates, especially in coastal plains, estuaries, and deltas. These ecosystems supply essential resources, such as organic matter for nutrient cycling, biomass for coastal food webs, and carbon storage for climate regulation(Mcowen et al., 2017).Furthermore, salt marsh plants stabilise sediment and provide fish and bird species with breeding grounds(Mitsch & Gosselink, 2015).
Large salt marshes, dominated by species like Spartina alterniflora and Spartina patens, are found throughout the Atlantic and Gulf coasts of North America. Salicornia europaea and Puccinellia maritima are two species that are supported by European salt marshes, which are located in the UK, France, and the Netherlands(Boorman, 2003).With a variety of halophyte species including Sueda australis and Atriplex portulacoides, salt marshes are significant carbon sinks in China and Australia(Saintilan et al., 2019).
Salt marshes are comparatively less common in India, mostly found in the Sundarbans mangrove habitat and along the coastlines of Gujarat, Tamil Nadu, and West Bengal(Nayak et al., 2018). Salicornia brachiata, Sueda nudiflora, and Aeluropuslagopoides are among the species that predominate in Indian salt marshes because they are suited to high salinity and recurring flooding(Gopal & Chauhan, 2006). In addition to sustaining biodiversity and carbon sequestration, these ecosystems supply resources for traditional livelihoods including salt extraction and fodder cultivation.
Threats to salt marshes include pollution, climate change, and land reclamation, notwithstanding their biological significance. To preserve the resources and ecological services that salt marsh plants offer,

conservation initiatives including habitat restoration and sustainable management are essential(Ghosh et al., 2015).

UTILIZATION AND BYPRODUCTS OF SALT MARSH PLANTS:

Because of their biochemical characteristics and capacity to adapt to saltwater conditions, salt marsh plants have important ecological, commercial, and industrial uses. These plants are important resources for human industries and coastal ecosystems since they can be used as food, fodder, biofuels, medicinal chemicals, and soil stabilisers(Rozema & Flowers, 2008).

The use of salt marsh plants in agriculture and animal feed is one of their main applications. Because of their high nutrient content and salt tolerance, species like Sueda maritima and Salicornia europaea are utilised as fodder(Ventura et al., 2015). Furthermore, several halophytes yield edible seeds and oil, which makes them viable options for saline farming(Zhang & Fan, 2019).

Additionally, salt marsh plants aid in the generation of biofuel. High amounts of biomass found in certain species, like Sarcocorniaquinqueflora and Spartina alterniflora, can be transformed into bioethanol and biodiesel(Kumar et al., 2016).Because of their phytochemical characteristics, which include antibacterial, anti-inflammatory, and antioxidant substances, they are useful in pharmaceuticals(Sharma et al., 2018).

Salt marsh plants produce biomass for renewable energy, extracts for therapeutic purposes, and organic matter that improves soil fertility. Their sustainable use can support both economic growth and conservation.

GLOBAL AND INDIAN RESEARCH ON SALT MARSH PLANTS:

Because of their ecological significance and possible uses in biotechnology, agriculture, and environmental management, salt marsh plants have been the subject of much research worldwide. Their ability to withstand extreme salinity and waterlogging, as well as their significance in mitigating climate change and sequestering carbon, are the main areas of global research(Mitsch & Gosselink, 2015).Sea level rise's effects on salt marsh vegetation have been studied in North America, Europe, and Australia, with a focus on the vegetation's role in protecting coastlines and conserving biodiversity(Saintilan et al., 2019). Additionally, studies have looked into the possibilities of halophytes like Salicornia and Spartina in sustainable agriculture, phytoremediation, and biofuel production(Rozema & Schat, 2013).

With an emphasis on their distribution, ecological roles, and possible commercial use, study on salt marsh plants is accelerating in India. Research has demonstrated the significance of plants such as Sueda maritima and Salicornia brachiata in coastal restoration, medicinal uses, and saline agriculture(Gopal & Chauhan, 2006).Researchers from India are also looking into how climate change is affecting salt marsh ecosystems, especially in the Gujarat and Sundarbans regions(Nayak et al., 2018).In order to preserve these important coastal habitats, efforts are being made to include salt marsh plants into conservation plans and land-use planning.

APPLICATIONS OF SALT MARSH PLANTS:

Because of their special biochemical characteristics and capacity to flourish in saltwater environments, salt marsh plants offer a wide range of uses in industry, agriculture, medicine, and environmental preservation. These plants are essential for reducing climate change, preserving coastal habitats, and producing useful materials for human consumption(Baldwin et al., 2019).

Carbon sequestration and coastal protection are two of the main ecological uses of salt marsh plants. By stabilising sediments and serving as organic barriers against storm surges and sea level rise, species like Salicornia europaea and Spartina alterniflora aid in the prevention of coastal erosion (Saintilan et al., 2019).Furthermore, these plants mitigate climate change by absorbing and storing large amounts of atmospheric carbon(Chmura, 2013).

The potential of salt marsh plants in saline farming is becoming more widely acknowledged in the agricultural industry. Some halophytes, such Atriplex portulacoides and Salicornia brachiata, are good substitutes for cultivation in soils impacted by salt because they yield high-quality vegetable oils, edible seeds, and animal feed(Rozema & Flowers, 2008).Additionally, they are beneficial for phytoremediation because of their capacity to absorb excess nutrients and heavy metals from contaminated settings(Mateos-Naranjo et al., 2013).

Additionally, salt marsh plants have important industrial and medical uses. Bioactive substances with antibacterial, anti-inflammatory, and antioxidant qualities are found in many halophytes and are used in both conventional and alternative medicine(Sharma et al., 2018).Furthermore, because of their high biomass output and capacity to grow on marginal lands without competing with food crops, these plants are being investigated as potential sources of biofuel(Ventura et al., 2015).

While promoting biodiversity conservation, the appropriate usage of salt marsh plants can have positive effects on the economy and ecology. To fully utilise their potential uses, more study and sustainable management techniques are needed.

CONCLUSION:

Because they offer ecological, financial, and environmental advantages, salt marsh plants are essential to coastal ecosystems. They are essential for maintaining shorelines, stopping erosion, and boosting biodiversity because of their capacity to flourish in salty, wet conditions. By retaining atmospheric carbon in their biomass and sediments, these plants—which include species like Spartina alterniflora, Salicornia europaea, and Atriplex portulacoides—help to mitigate the effects of climate change.Salt marsh plants provide a variety of purposes in industry, agriculture, and medicine in addition to their ecological roles. By creating edible seeds, oils, and animal feed, they provide sustainable alternatives for saline farming. Their bioactive compounds have promising medicinal properties, including antioxidant and antimicrobial effects. Additionally, their potential use in biofuel production and phytoremediation highlights their role in sustainable resource management. Despite all of these advantages, pollution, climate change, habitat loss, and sea level rise are posing a growing danger to salt marsh ecosystems. To maintain their ecological integrity and guarantee the continuous availability of their resources, conservation and restoration initiatives are crucial. These priceless coastal ecosystems can be preserved with the use of sustainable management techniques like habitat preservation and restricted cultivation.In summary, salt marsh plants have great potential for human use in addition to being essential parts of coastal ecosystems. To optimise these plants' advantages and preserve delicate salt marsh environments for future generations, further research, conservation, and sustainable use are required.

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