Deep Science Publishing
https://doi.org/10.70593/978-93-49307-18-6_6

Chapter 6

Mangroves: Treasure of novel bioactive compounds

R Hadassa [1], M Aruna Kumari [2] T Vijaya [3*]

[1] *Government Degree College, Nagari, Chitoor District, A.P., India*
[2, 3*] *Department of Botany, Sri Venkateswara University, Tirupati-517502., AP., India*

[2*] vijayasvu@gmail.com

Abstract: Mangroves are unique coastal ecosystems found in tropical and subtropical regions, renowned for their ecological and economic importance. Beyond their role in protecting shorelines and supporting biodiversity, mangroves are a rich source of novel bioactive compounds with immense potential in medicine, agriculture, and industry. These compounds, including alkaloids, flavonoids, tannins, terpenoids, and phenolics, are produced as secondary metabolites to help mangroves thrive in extreme environments. They exhibit diverse biological activities such as antimicrobial, antioxidant, anti-inflammatory, anticancer, and antifouling properties. Additionally, mangrove-associated microorganisms, such as fungi and bacteria, further contribute to the production of bioactive compounds with unique characteristics. The potential applications of these compounds span several fields: pharmaceuticals (drug discovery, antimicrobial agents, anticancer therapies), agriculture (biopesticides, biofertilizers, and plant growth enhancers), and environmental science (antifouling agents and bioremediation). Despite their promising benefits, challenges such as biodiversity loss, unsustainable harvesting, and limited research on their mechanisms of action must be addressed to harness their full potential.

Keywords: Mangroves, Bioactive compounds, Biodiversity, Pharmacology and Sustainability

Citation: Hadassa, R., Kumari, M. A., & Vijaya, T. (2025). Chapter title. In *The Unity of Life: Interdisciplinary Connections across the Sciences* (pp. 54-58). Deep Science Publishing. https://doi.org/10.70593/978-93-49307-18-6_6

1. Introduction

Mangroves are salt-tolerant trees and shrubs found in intertidal zones of tropical and subtropical regions. These unique ecosystems play vital ecological roles, such as protecting coastlines, preventing soil erosion, and serving as breeding grounds for marine life. Beyond their ecological importance, mangroves are a treasure trove of novel bioactive compounds with immense potential in medicine, agriculture, and industry. The extreme environmental conditions in which mangroves thrive high salinity, anaerobic

soil, and tidal fluxes drive the production of unique secondary metabolites, making them a valuable resource for the discovery of bioactive compounds.

2. Bioactive Compounds in Mangroves

Mangroves and their associated microorganisms produce a wide range of bioactive compounds, including alkaloids, flavonoids, terpenoids, tannins, saponins, and phenolics. These compounds exhibit diverse biological activities such as antimicrobial, antioxidant, anti-inflammatory, anticancer, and antifouling properties.

i. Phenolic Compounds

Mangroves are rich in phenolic compounds, which have strong antioxidant properties. These compounds neutralize free radicals, protecting cells from oxidative stress and related diseases like cancer, diabetes, and cardiovascular disorders.

ii. Alkaloids

Mangroves produce alkaloids with antimicrobial and cytotoxic activities. For instance, alkaloids derived from Avicennia marina and Rhizophora mucronata have shown promising results in combating bacterial infections and cancer cells.

iii. Terpenoids

Terpenoids are abundant in mangroves and exhibit antifungal, antibacterial, and anticancer properties. These compounds are widely studied for their potential in drug development.

iv. Tannins

Tannins extracted from mangroves like Rhizophora apiculata and Bruguiera cylindrica possess strong antimicrobial and antioxidant activities. They are used in traditional medicine to treat wounds and infections.

v. Polysaccharides

Mangrove-derived polysaccharides, such as sulfated polysaccharides from Kandelia candel, have anticoagulant and immunomodulatory effects, making them potential candidates for pharmaceutical applications.

3. Bioactive Compounds from Mangrove-Associated Microorganisms

Mangrove ecosystems are home to a diverse community of microorganisms, including fungi, bacteria, and actinomycetes, which produce unique bioactive compounds.

Fungi:

Mangrove-associated fungi produce antibiotics, enzymes, and anticancer compounds. For example, Penicillium sp. isolated from mangroves produces secondary metabolites with antifungal properties.

Bacteria:

Mangrove bacteria, especially from the genera Streptomyces and Bacillus, are a source of antimicrobial compounds effective against drug-resistant pathogens.

Actinomycetes: These filamentous bacteria produce anticancer, antiviral, and immunosuppressive agents.

4. Applications of Mangrove Bioactive Compounds

i. Pharmaceuticals:

- Antimicrobial compounds from mangroves are used to develop antibiotics to combat multidrug-resistant pathogens.
- Anticancer compounds from mangrove species like Sonneratia alba and Avicennia officinalis have shown potential in preclinical studies.

ii. Agriculture:

- Mangrove-derived bioactive compounds are used to develop biopesticides and biofertilizers, reducing the reliance on chemical inputs in agriculture.
- Antifungal agents from mangroves help control plant pathogens.

iii. Cosmetics:

Antioxidants from mangroves are incorporated into skincare products to protect against UV-induced damage and aging.

iv. Food Industry:

Mangrove tannins and flavonoids are used as natural preservations due to their antimicrobial properties.

v. Environmental Applications:

Antifouling compounds from mangroves prevent the accumulation of biofilms and marine organisms on submerged surfaces, reducing maintenance costs for marine vessels and structures.

5. Challenges and Future Prospects

Despite their potential, the exploration of mangrove bioactive compounds faces several challenges:

- **Biodiversity Loss:** Mangroves are under threat from deforestation, pollution, and climate change, limiting access to these valuable resources.
- **Sustaianable Extraction:** Overharvesting can harm mangrove ecosystems. Sustainable methods must be developed to extract bioactive compounds.
- **Scientific Validation:** Many traditional uses of mangrove compounds lack rigorous scientific validation. Further research is needed to understand their mechanisms of action and potential side effects.

Future Research should focus on:

- Exploring mangrove – associated microbiota for novel compounds.
- Applying advanced techniques like metabolomics and genomics for compound discovery.
- Developing sustainable harvesting practices to protect mangrove ecosystems.

Conclusion

Mangroves are a treasure trove of novel bioactive compounds with immense potential in medicine, agriculture, and industry. Their unique metabolic pathways, driven by harsh environmental conditions, produce compounds with diverse biological activities.

Protecting and sustaianably utilizing mangrove resources is essential to unlock their full potential while preserving these vital ecosystems for future generations.

References:

Bandaranayake, W. M. (2002). Bioactivities, bioactive compounds and chemical constituents of mangrove plants. *Wetlands Ecology and Management*, *10*(6), 421–452. https://doi.org/10.1023/A:1021397624349

Choudhury, B., & Sharma, P. (2020). Bioactive metabolites from mangrove ecosystems and their associated microbes. *Microbial Ecology*, *80*, 121–135. https://doi.org/10.1007/s00248-019-01469-

Kannan, R. R., Arumugam, R., & Anantharaman, P. (2010). Antibacterial potential of marine mangrove plants against multidrug-resistant pathogens. *World Journal of Microbiology and Biotechnology*, *26*(1), 143–149. https://doi.org/10.1007/s11274-009-0152-6

Kathiresan, K., & Bingham, B. L. (2001). Biology of mangroves and mangrove ecosystems. *Advances in Marine Biology*, *40*, 81–251. https://doi.org/10.1016/S0065-2881(01)40003-4

Ragavan, P., & Das, S. S. (2021). Potential bioactive compounds from mangroves for pharmaceutical and agricultural applications. *Journal of Pharmacy and Bioallied Sciences*, *13*(2), 173–182.

Ravikumar, S., Gnanadesigan, M., Suganthi, P., & Ramalakshmi, A. (2012). [Missing title]. *Botanical Review*, *72*(4), 297–309. https://doi.org/10.1007/s12229-006-9003-5

Sangeetha, R., & Bhaskara Rao, K. V. (2016). Mangroves: A potential source for production of bioactive compounds. *Asian Journal of Pharmaceutical and Clinical Research*, *9*(2), 34–39.

Sheeba, T. (2012). Antimicrobial activity of mangrove plants. *International Journal of Research in Pharmaceutical and Biomedical Sciences*, *3*(3), 1012–1015.

Sukumaran, A. (2018). Mangroves and their bioactive compounds. In P. N. Bhargava (Ed.), *Biotechnology for Sustainable Agriculture* (pp. 203–215). Springer. https://doi.org/10.1007/978-981-13-3670-1_11

Venkatesalu, V., & Chelliah, K. (2019). Phytochemistry and pharmacology of mangroves. In M. Egamberdieva, A. Shrivastava, & S. Varma (Eds.), *Plant-Growth-Promoting Rhizobacteria (PGPR) for Sustainable Agriculture* (pp. 139–150). Springer.