West Kazakhstan Medical Journal
Volume 66, Issue 2, DOI 10.18502/wkmj.v66i2.16458
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Mini Review

Unveiling the Healing Potential of *Avicennia marina*: A Mini Review on its Medicinal Marvels

Aymen Abdulateef Alrubaye[1]*, Reshad Moradi Balef[2], Siavash Kalbi[3], and Nader Tanideh[4]

[1]Marine Science Center, University of Basrah, Basreh, Iraq
[2]Beauty Planet Association, Bushehr, Iran
[3]Forestry Department, General Department of Natural Resources and Watershed Management of Bushehr Province, Bushehr, Iran
[4]Stem Cells Technology Research Center and Department of Pharmacology, School of Medicine, Shiraz University of Medical Sciences, Shiraz, Iran

Abstract

This mini review delves into the therapeutic attributes of *Avicennia marina*, commonly known as the Grey Mangrove, situated within mangrove ecosystems. Characterized by unique biochemical features, *A. marina* has captured the attention of the scientific community for its potential medicinal applications. Thriving in intertidal zones amidst salinity fluctuations and environmental stressors, this resilient mangrove species has evolved adaptive mechanisms, leading to the synthesis of secondary metabolites with recognized pharmacological properties. Beyond its immediate relevance in medical research, *A. marina* emerges as a significant player in environmental health, especially in the context of escalating climate change challenges. The intertidal zones it inhabits face increasing vulnerability to rising sea levels and temperature fluctuations, emphasizing the importance of understanding its adaptive mechanisms for both medicinal and ecological insights. Moreover, *A. marina* serves as a testament to the intricate interplay between nature and human health. Bioactive compounds found in this mangrove not only hold promise for pharmaceutical applications but also contribute to the burgeoning field of herbal medicine. Integrating traditional knowledge with modern scientific approaches provides a holistic understanding of the Grey Mangrove's therapeutic spectrum, unveiling potential herbal remedies with relevance to contemporary healthcare practices. This dual perspective positions *A. marina* as a subject of interdisciplinary research, where botanical pharmacology intersects with ecological resilience, addressing both medical and environmental challenges.

Keywords: Grey Mangrove, *A. marina,* intertidal zones

Corresponding Author: Aymen Abdulateef Alrubaye; email: aymen.kwyes@uobasrah.edu.iq

Received: 1 February 2024
Accepted: 13 February 2024
Published: 28 June 2024

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1. Introduction

Avicennia marina, colloquially known as the Grey Mangrove, represents a distinctive component of mangrove ecosystems [1], exhibiting unique biochemical characteristics that have drawn attention to their potential therapeutic applications [2]. As the scientific community endeavors to uncover novel sources of pharmacologically active compounds, *A. marina* stands as a promising candidate, offering a reservoir of bioactive constituents with implications for medical research and development [3].

The Grey Mangrove thrives in intertidal zones, where it encounters fluctuating salinity levels and environmental stressors [4]. Despite these challenges, *A. marina* has evolved an array of adaptive mechanisms, resulting in the synthesis of secondary metabolites with recognized pharmacological properties [5]. This mini review seeks to provide a comprehensive overview of the medicinal attributes associated with *A. marina*, focusing on its biochemical composition and potential therapeutic applications.

Furthermore, beyond its immediate significance in medical research, the Grey Mangrove plays a pivotal role in the broader context of environmental health, particularly amidst the escalating challenges posed by climate change [6, 7]. The intertidal zones that *A. marina* inhabits are increasingly vulnerable to the impacts of rising sea levels and temperature fluctuations, making the adaptation strategies of this mangrove species a subject of particular interest [8]. Understanding the molecular intricacies of its adaptive mechanisms not only contributes to our knowledge of its medicinal potential but also sheds light on its resilience in the face of environmental stressors [9].

Moreover, *A. marina* is emblematic of the intricate interplay between nature and human health, as its bioactive compounds hold promise not only for pharmaceutical applications but also for the burgeoning field of herbal medicine [10]. Traditional communities residing in coastal areas have long recognized the healing properties of *A. marina*, utilizing its various parts for diverse medicinal purposes [11]. Integrating this traditional knowledge with modern scientific approaches allows for a more holistic understanding of the Grey Mangrove's therapeutic spectrum, potentially unveiling novel herbal remedies with relevance to contemporary healthcare practices [12].

This dual perspective, encompassing both the medicinal and environmental facets of *A. marina*, positions this mangrove species as a nexus of interdisciplinary research, where insights from botanical pharmacology converge with ecological resilience in the face of climate change.

1.1. Bioactive Compounds in *A. marina*

A thorough examination of the chemical composition of *A. marina* reveals a complex interplay of secondary metabolites [13]. Tannins, flavonoids, and other phytochemicals have been identified in various plant parts, including leaves, bark, and roots [14]. These compounds, often recognized for their anticancer (Figure **1**), antioxidant, anti-inflammatory (Figure **2**), and antimicrobial activities, form the basis of the Grey Mangrove's medicinal profile [15]. Table 1 elucidates the specific bioactive constituents identified in *A. marina* and their potential pharmacological relevance.

Among these compounds, quercetin and kaempferol, as flavonoids, appear to have the most promising pharmacological activities due to their multifaceted effects, including antimicrobial,

Table 1: A concise overview of the diverse classes of bioactive compounds identified in *Avicennia marina* and their distribution across different plant parts.

Compound Class	Identified Compounds	Plant Parts	Pharmacological Activities	References
Tannins	Gallotannins, Ellagitannins	Bark, Leaves	Antioxidant, Anti-inflammatory	[16]
Flavonoids	Quercetin, Kaempferol, Myricetin	Leaves	Antimicrobial, Anti-inflammatory, Antioxidant	[17]
Alkaloids	Vasicine, Vasicinol	Leaves, Roots	Antimicrobial, Anti-inflammatory	[18]
Terpenoids	α-Pinene, β-Pinene, Limonene	Bark, Leaves	Antioxidant, Anti-inflammatory	[19]
Phenolic Compounds	Protocatechuic acid, Catechin	Leaves	Anti-inflammatory, Antioxidant	[20]

anti-inflammatory, and antioxidant properties (21). These compounds have been extensively studied for their potential therapeutic applications in various health conditions. The pharmacological activities associated with each compound class underscore the multifaceted therapeutic potential of *A. marina*. The elucidation of these specific bioactive constituents lays the foundation for further research into their molecular mechanisms and potential applications in medicine and pharmaceuticals.

Understanding the potential synergistic effects of the identified bioactive compounds in mangroves is crucial for comprehensively evaluating their therapeutic potential [2]. Synergy occurs when the combined effect of two or more compounds is greater than the sum of their individual effects [22]. In the case of mangrove extracts, the presence of multiple bioactive compounds with diverse pharmacological properties suggests the possibility of synergistic interactions [23]. For example, compounds like quercetin and curcuminoids may interact synergistically to enhance antioxidant and anti-inflammatory effects, thereby augmenting the overall therapeutic efficacy of mangrove extracts [24]. Investigating these synergistic interactions can provide valuable insights into the complex mechanisms underlying the health-promoting effects of mangroves and inform the development of synergistic formulations for medicinal applications. Further research in this area is warranted to unlock the full therapeutic potential of mangrove-derived compounds.

2. Mangrove Forests and Human Health

Mangrove forests, with their intricate network of tangled roots and lush canopies, are not merely coastal ecosystems; they represent a vital interface where the health of the environment intertwines with the well-being of human communities [25] (Figure **3**). The impact of mangrove forests on human health is multifaceted, encompassing both direct and indirect contributions that extend far beyond the immediate coastal zones [26].

Mangrove forests act as natural barriers, providing coastal communities with invaluable protection against the ravages of tropical storms, hurricanes, and tsunamis [27]. The intricate root systems of mangroves act as a buffer, absorbing and dissipating the energy of waves, thereby reducing the risk of coastal erosion and minimizing the impact of storm surges [28]. This protective

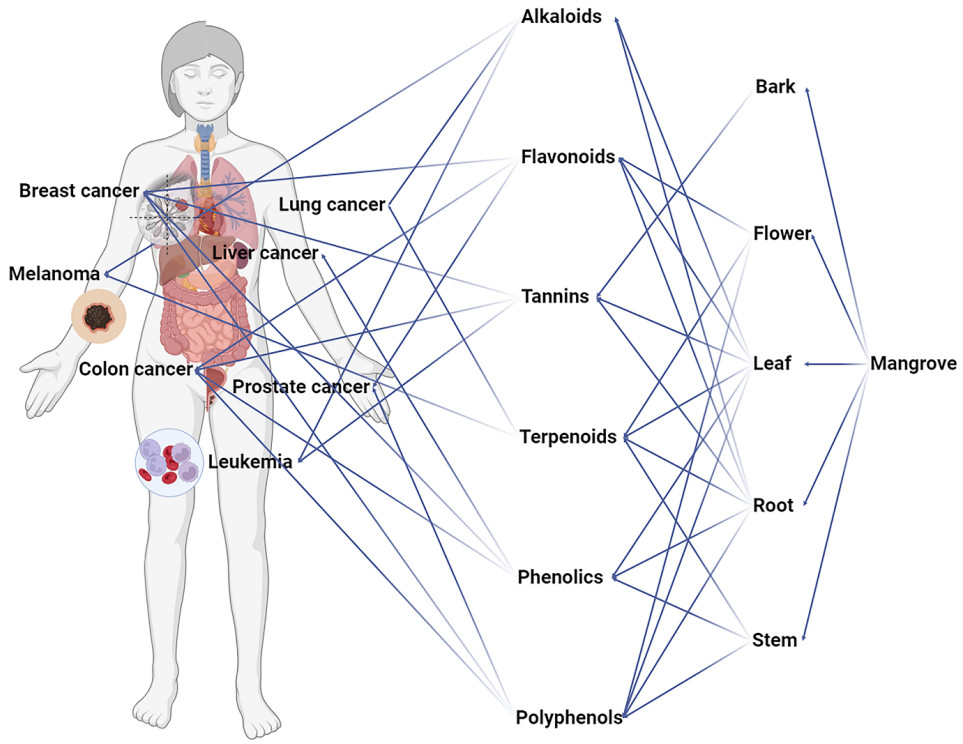

Figure 1: Mechanisms of anticancer activity of mangrove extracts. This figure highlights key components such as bioactive compounds present in mangrove extracts and their interactions with cancer cells, leading to various anticancer effects (the figure is designed by BioRender).

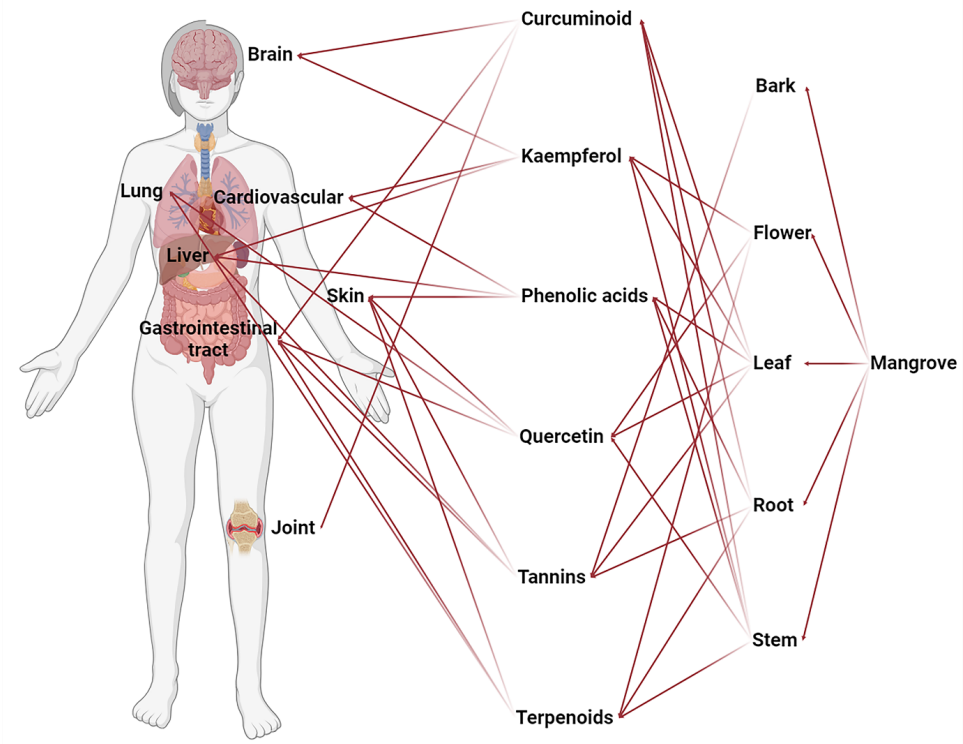

Figure 2: Mechanisms of antioxidant and anti-inflammatory activities of mangrove extracts. This figure highlights key components such as bioactive compounds present in mangrove extracts that have antioxidant and anti-inflammatory effects (figure is designed by BioRender).

function not only safeguards local infrastructure but also ensures the physical safety of inhabitants,

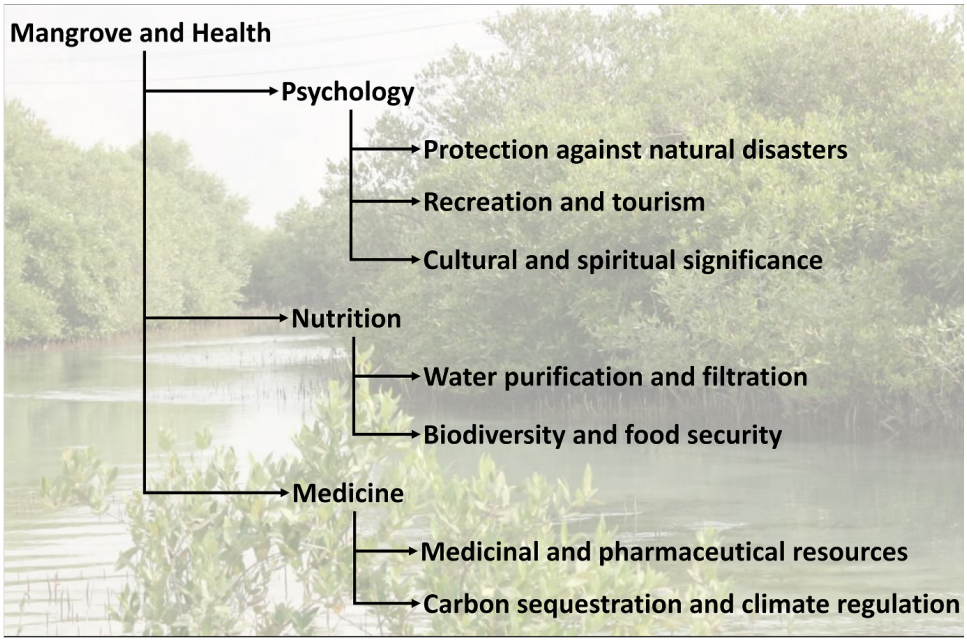

Figure 3: Dimensions of health: nutrition, psychology, and medicine. This figure illustrates the multidimensional nature of health, categorizing it into three main dimensions: nutrition, psychology, and medicine. Each dimension encompasses various factors and subcategories that contribute to overall well-being, highlighting the interconnectedness and complexity of human health.

significantly enhancing community resilience in the face of natural disasters [29].

Mangrove ecosystems play a pivotal role in maintaining water quality and nutrient cycling in coastal areas [30]. The dense root systems of mangroves filter pollutants, trapping sediment and impurities before they reach open waters [6]. This natural filtration process helps to purify coastal waters, reducing the risk of waterborne diseases and enhancing the overall quality of water resources accessible to nearby communities [31]. Moreover, mangroves act as nutrient cycling hubs, influencing the availability of essential elements for aquatic ecosystems, which, in turn, contributes to the sustenance of fisheries and the livelihoods of coastal communities dependent on marine resources [30].

Beyond the tangible ecological services, mangrove forests offer intangible yet invaluable benefits to human health [32]. Access to green spaces has been consistently associated with improved mental health and well-being [32]. Mangrove forests, with their serene landscapes and rich biodiversity, provide opportunities for recreation, relaxation, and stress reduction [6]. Studies have shown that exposure to natural environments like mangrove forests can alleviate psychological stress, enhance mood, and contribute to an overall sense of well-being [33]. In this way, the health of mangrove ecosystems is intricately linked to the health of the communities that coexist with them.

3. Conclusions

In conclusion, the Grey Mangrove, *A. marina*, stands as a botanical treasure trove with immense potential for medicinal and environmental applications. Our exploration of its unique biochemical composition and adaptive mechanisms highlights its significance in medical research, offering a repertoire of bioactive compounds with diverse pharmacological activities. Beyond its role in pharmaceutical pursuits, *A. marina* plays a crucial role in environmental health, particularly in the face

of climate change-induced challenges. Its adaptive strategies provide insights into both its resilience and potential applications in mitigating environmental stressors. Furthermore, the integration of traditional knowledge into our understanding of *A. marina*'s therapeutic properties emphasizes its cultural and historical relevance, paving the way for novel herbal remedies. This mini review underscores the dual perspective of *A. marina*—bridging the gap between medicinal and environmental sciences, illustrating its potential as a nexus for interdisciplinary research with implications for human health and ecological sustainability.

3.1. Future research protentional on A. marina

Based on the presented findings, potential avenues for future research on mangroves include investigating the mechanisms of action of specific bioactive compounds, exploring novel extraction methods to enhance bioavailability, conducting clinical trials to evaluate efficacy and safety in humans, and assessing the potential ecological impacts of harvesting mangrove-derived compounds. These avenues could further elucidate the therapeutic potential of mangroves and contribute to the development of new pharmaceuticals and nutraceuticals.

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