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Mangroves and Their Medicinal Benefit: A Mini Review

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ABSTRACT

Mangrove plants have been utilized by humankind for so long. It is widely suggested that there are still many benefits to these mangroves that are not yet discovered. This article examines the current researches in the usage of mangroves as medicine. Many of these researches revolve around the potential use of mangrove as anticancer, antitumor, anti-inflammatory, antifungal, antibacterial, antiviral, and antidiabetic. Studies have shown that mangroves indeed have numerous benefits and untapped potential in the medical field. This article will also review the current state of conservation and preservation of mangrove plants in the world.

Keywords: Mangroves, Medicinal Plants, Conservation and Preservation

ABBREVIATIONS

HIV: Human Immunodeficiency Virus.
AGEs: Advanced Glycation End-Products.

INTRODUCTION

Mangrove forests provide critical benefits around the globe to both humans and the ecosystems they occupy. Their swamps span roughly 181 thousand km^2, and they can be found along the coastlines of the world.[1]

Mangroves have been used as a medicine and have been studied by humans since centuries ago. Many varieties have been utilized, and extracts from different species of mangroves are proven

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effective against pathogens. Secondary metabolites such as alkaloids, phenolic, steroids, and terpenoids can be found in mangrove extracts and have been observed to hold toxicological, pharmacological, and ecological significance.[2] Despite all of this; the general public is still clueless about the benefits that the mangrove plants can provide.

REVIEW

Human beings have been using natural products like plants, livestock, microorganisms, and marine organisms in medicines since ancient times to prevent and cure diseases. Herbal medicine use over the centuries has gone through ups and downs, nonetheless human still relies heavily on herbal medicine.[3]

A. Introduction to Mangroves

Mangroves are mainly recognized for their thick aerial roots. These aerial roots are above ground roots, and since mangrove trees are most commonly found on coastlines, the roots make them appear to be standing on top of the water surface. One of their recognized capability is functioning as a tidal shield. The mangrove trees are capable of preserving the ground from abrasion. Mangroves ecosystem have to endures the frequent shifts in the tidal, strong winds, high temperatures, anaerobic soils, and salinity gradient of the mangrove habitat as the driving forces for metabolic pathway adaptations, which can direct the production of useful metabolites but also can cause to diminished of the mangrove ecosystem.[4] Mangroves have evolved some morphological and physiological responses that allow them to overcome the drawbacks of these harsh conditions.[5]

One of many unique abilities that mangrove possess is to maintaining its freshwater level in their root systems. Due to the unique locations where mangroves are typically found, mangrove needs to retain its freshwater level.[6] Mangroves are typically divided into three different categories, the major species, the minor species, and the mangrove associates; however, mangroves have proven to be difficult to classify.[7]

B. Phytochemical of Mangroves

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Phytochemicals can be categorized as carotenoids, phenolics, alkaloids, flavonoids, and compounds containing nitrogen and compounds containing organosulfur. Phenolics and carotenoids are the most researched of the phytochemicals.[8]

Since a long time ago, medicinal plants of different origins have been used to treat wounds, burns, and even severe health problems. Rapid progress has been established in phytochemical analysis and herbal goods. Nonetheless, the chemical compounds of most mangrove plants are not extensively studied yet.[9] Different colors can be used to identified and analyze other compounds of phytochemical contents.[10]

C. Spread of Mangroves Throughout The World

Mangroves are well spread out around the world in 123 tropical and subtropical countries consisting of 74 true mangrove species, including trees, shrubs, palms, and ferns.[11]

In Africa, mangrove populations are well spread out throughout. Over 70 true mangrove species have been recorded from all around the world, and this number may not be specific due to many of its genus have been wiped out by the villages surrounding the area. The distribution of the species is quite varied, from the known species of mangrove, 8 out of 17 of these mangroves are distributed in 26 African countries while 19 out of them are in mainly in West part of Africa and the other nine species are expanse in 7 countries around East African Countries. As regards the distribution portions the mangroves population also extends its dispersal [11] South America occupies quite a large number of mangroves habitat with 50% of its population located in Brazil.[12]

Out of all the regions in the world, Asia is always considered to have the best mangrove distribution. The distribution of mangrove in Asia, compared to other continents, is regarded as the most diverse and well-distributed. An area called the Sundarbans is the largest mangrove forest in the world and is widely acclaimed for its biodiversity. The Asian continent is highly ideal for the growth of mangroves as it has long coastlines, a wide range of climates from arid, like in the Arabian Peninsula, to subtropical, like in China and Japan, as well as humid tropical, like in the Southeast Asia region.

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Southeast Asia region has the most populated mangrove. Being the home to 30.9% (47,000km^2) of the world population, Southeast Asia also has a vast coastline of almost 173,251 km and has the most complex coral reef ecosystems of the world. Mangrove populations of Southeast Asia are the most diversified in the world. Southeast Asia consists of 52 true mangrove species. The aquaculture industry has been held primarily responsible for mangrove deforestation in Southeast Asia over the past 30 years.[12]

The Australian mangroves are 11500 km^2, which representing 6.4 percent. and it is the world's third-largest mangrove region.[12] Mangrove in New Zealand is restricted to the northern coastlines of the North Island as opposed to another area.[12]

Indonesia is an archipelago nation; it has remarkably long coastlines and home to over 17,504 islands (28 larger islands and 17,475 lesser islands). The total length of the coastline is approximated to be 95,181 km. Indonesia boasts a staggering number of 20% of the whole mangrove population around the world. The mangrove populations is well-distributed all over most of the Indonesian larger islands. They are spread extensively along most of the coastlines and also the estuaries. They are found in various groups, whether mixed or pure stands, and are spread mainly on the five major islands of Indonesia, which are the Java island, Sumatra island, Kalimantan island, Sulawesi island, and Papua island.[13]

D. Threats to Mangroves Habitat

There are many threats surrounding mangrove habitat, such as sea level rises; this is a result of global warming with the increasing temperature on Earth, thus resulting in many of the icebergs melting, making the water level continue to increase, thus causing a significant impact on the mangrove surrounding the ecosystem and its survival. Elevating weather changes have led to a change in the volume of the world ocean.[14]

The uneven and many deforestations happening is causing significant changes in the precipitation rate and thus harming the mangrove habitats. It is believed in 2050; the rainfall will increase by about 25% in response to the current climate change. Nonetheless, the current rain distribution will be very uneven, causing a significant decrease in precipitation; this will probably occur in poleward subtropical regions.[15] The area with less precipitation level will

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likely have smaller water input, causing the increase in tissue salt on mangrove habitats. Mangrove populations become more vulnerable and more likely to die out due to the lack of freshwater and an abundance of salt in the sediment.[16]

Elevation in temperature and CO2 in the atmosphere has shown a significant impact on the mangroves' ecosystem. Numerous abiotic, flora, and fauna on the surrounding mangroves' ecosystem are leaning to a critical state, and studies predicted that the ecosystem could not keep up with the global climate change.[17] As a result of warmer air temperatures, plant mass only in mangrove areas increased dramatically, possibly due to an increase in photosynthate available for allocation below ground.[18]

An increase in storms frequencies and intensity has momentously impacted mangrove habitats, especially in America, Australia, and Africa. The effect may cause prolonged damage, but further studies need to be conducted to ensure the full impact of the increased intensity of storms.[19] The biggest threat to the mangrove ecosystem is deforestation; the biggest can be seen in Java Island in Indonesia; more than 50 % of the mangrove area has been gone due to deforestation, and the first recorded history of deforestation was around 1400 during the Majapahit Kingdom in Indonesia for the production of shrimp extractions.[20]

E. Mangroves Conservation and Preservation

To respond with the loss of mangrove area, the movement to protect and conserve the mangrove ecosystem is becoming more prominent, and the answer comes from the government and many communities and associations across the globe. In preference, there have been more fundamental approaches and a more diverse idea to managed the protection of mangrove habitat.[21]

The status and management regarding preserving mangrove habitat have been established, although there are still parties that do not follow nor cooperate with the already established act. Gradually the view of society and public awareness is starting to show some improvement. Since the early 1990s, mangrove restoration is being promoted, and projects are happening across the globe. For instance, over 300,000 mangroves trees were cultivated during 1993-1995 at Gazi Bay, Kenya.[22]

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National and global laws have been made to improve the habitat of mangrove, the highlight of the regulations is especially to prohibit more significant damage to the mangrove in many of the rules being based on the terrestrial system and most of the time, these regulations do not consolidate with the variety of the habitat, and the species mangroves itself. The most significant change that can be done is by utilizing the local communities near the habitat. Increasing the local knowledge and educating them on the importance of mangrove can make profound changes [23]

One of the implemented conservations and preservation of mangrove ecosystems that have shown a positive result is applying "Integrated coastal zone management".[11] Being this issue has been viewed as a global catastrophe. For this reason, mangrove restoration is needed more than ever, and every single party either, from the government, non-government organizations, need to partake in this regard.[24-26]

F. Utilization of Mangroves in Non-Medical Fields

Mangrove has been around for a long time to hence the use of mangrove has been varied many villages all over the world use mangrove wood as the foundation to make their houses, boats, furniture, fences, bridges even poles for the fish traps; this has been confirmed with the archaeological evidence in South America, Polynesia, and Pacific Oceans. Mangroves are also being consumed and used as fuelwood to make salt in the Spanish period in South America and Africa. The processes to produce salt used boiling brackish water, and it is cooked inside a clay pot, and the fire is made using mangrove wood from *Avicennia spp*. Many of the sources have confirmed that *Sonneratia caseolaris* are can be used to produce fruit beverages. Even the ash and wood from *Avicennia africana* can be used as a supplement for oil.[27]

G. Utilization of Mangroves in Medical Fields

Mangroves are used to treat many illnesses in all around the world; for instance, *Acanthus ilicifolius* make excellent stimulant, expectorant, and nervine tonic. Simultaneously, the root is boiled and mixed in milk used as coughs and asthma medicine. Mangrove has been used as traditional medicine since many periods ago.[28] With vast biological resources that have been put

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on the microscope, mangroves potential in medical used are very promising that has an excellent possibility for medical revelation.[29]

H. Utilization of Mangroves in Modern Medicines

Drug development from plant materials of the biological compounds and the process of determining the active compounds' structures from the extracts continue to increase and popularize. Natural products hold many new benefits that may lead to new drug discover.[30] The primary point of drug discovery is in the availability of the source. Exploring pristine or untouched habitat can lead to a more abundant source of mangrove.[31]

a. Mangroves as Anticancer

The secondary metabolites in mangroves are useful against cancer cells.[32] The search for bioactive compounds from coastal mangroves in the pharmacological area is still being ignored even though many researched prove that mangroves can be a good source of natural drugs.[32] From the secondary metabolites, antioxidants can be found and use as a drug. The antioxidants are also useful in maintaining the homeostasis of the immune system. Although there are certain drawbacks of introducing antioxidants, it is clear that the advantages are beneficial and cannot be neglected.[33]

An example of a mangrove plant showing anticancer properties is the *Ceriops decandra;* a small mangrove plant can be found in the tropical Asia region.[34] It is, however, found in abundance in Indonesia, specifically in Madura Island, although the mangrove plants supported the residents, as it is the perfect environment for oysters, and residents have been harvesting the oysters for them to sell then.[35] The black tea extract was useful in preventing carcinogenesis in the buccal pouch of the hamsters.[36]

b. Mangroves as Antitumor

The extracted mangrove shows seven compounds that can inhibit as antitumor assay.[37] Large concentrations of 4-pyrrolidinyl, ketone, and pyrazole derivatives can be found on *Rhizophora apiculata* mangrove extracts, which can be passed down as antitumor and anti-inflammatory agent.

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c. Mangroves as Anti-Inflammatory

The mangrove extracts have proved to be a positive outcome and an essential plant in indigenous medicinal practices. the research shows that the activities found could lead to a potential anti-inflammatory agent.[38] *RRhizophora apiculata* also reported to have anti-inflammatory by the founding of methanolic extracts, which may lead to the production of the high content of ketone derivatives, thiazolidine-diones, and 4-pyrrolidinyl.[38]

A critical aspect required by the mangrove extract to be useful as an anti-inflammatory drug is its flavonoid composition. Flavonoid is a class of secondary metabolites commonly found in plants and generally consists of 15 carbon atoms. Many flavonoids directly affect the enzymes responsible for inflammatory processes. Some flavonoids can inhibit the induction of adhesion molecules such as blood neutrophils, which is necessary for the inflammatory process.[39] The relation of the structure of all compounds showed a positive result; the extracts have potential as an anti-inflammatory agent. Nonetheless, there are still plenty of modifications that need to be done to be used as anti-inflammatory drugs.[40]

d. Mangroves as Antiviral

The bark from *Rhizophora mucronata* and leaf from *Rhizophora apiculata* were identified to have an active substance of acid polysaccharides which can block the binding mechanism process of Human Immunodeficiency Virus (HIV) inside cells.[41] The binding process is stopped by acid polysaccharides (sulphate polysaccharides) using the electrostatic interaction between the negative charge.[42]

e. Mangroves as Antifungal and Antibacterial

The actinomycetes in mangroves have great potential to produce as a new antibiotic; the available antibiotics in the market still has a problem controlling the disease.[43] The novel antibiotics are the key to producing a new type of medicines that can illuminate the resistant strains and actinomycetes; this can only be achieved if the experiments are conducted in the unexplored or touched areas. Therefore, the mangrove is more likely to possess more antioxidants.[44]

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f. Mangroves as Antidiabetic

The possibility of using mangrove as antidiabetic drugs can be seen in its association with the oxidative stress complication. With mangrove occupying the antidiabetic components such as; insulin-mimetic activity, decreasing intestinal glucose absorption, decreasing advanced glycation end-products (AGEs) and by exerting an antioxidative effect, thereby reducing oxidative-stress-associated diabetic complications, the following chemical structures of hypoglycaemic from mangroves.[45]

g. Most Researched Mangroves

There are mangrove samples that had been researched and analyzed their phytochemical constituents and their inherent biological activity as seen in Table 1 and 2 (Appendix). Most of these plants were known traditionally as a medicinal source of nearby settlements, which for some had been proven to contain some chemicals that are beneficial as medicinal as well as agricultural and industrial uses.

CONCLUSION

There are many uses of mangroves. Humans are vulnerable to many diseases and viruses. To seek a new alternative source of drugs has become prominent. Mangrove plants have proven to have the potential to be used as anticancer, antitumor, anti-inflammatory, antiviral, antifungal, antimicrobial, and antidiabetic in medicine.

With all these benefits that the mangrove plants can provide to the medical field, there is no doubt that they are an essential member of medicinal plants and should be treated that way.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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TABLES AND FIGURES

I. Table 1 : Mangrove Researched on Global Use.[46]

Mangrove Species	Traditional Use	Recent Research Conducted on Mangrove	Chemical Compounds
Acanthus ilicifolius	Asthma, Diabetes, Hepatitis, Skin disease, Rheumatism	Antiviral, Antidiabetic	Alkaloids, Saponins,
Avicennia marina	Rheumatism. Small pox, Ulcers	Analgesic, Antiviral, Antifungal	Glycosides
Bruguiera exaristata	Hepatitis	Antiviral, Antitumor	Alkaloids
Bruguiera gymnorrhiza	Treatment of eye diseases	Antimicrobial, Antidiabetic	Phenolics, Alkaloids, and Terpenoids
Ceriops tagal	Haemorrhages	Antitumor	4-pyrrolidinyl, ketone, and Pyrazole derivatives
Cyperus rotundus	Control insect	Antifungal	Alkaloids, Phytotoxins, Sesquiterpenes
Lumnitzera littorea		Antimicrobial	Alkaloids, Tripenoids, Flavonoids
Rhizophora apiculata	Treatment of elephantiasis, Hematoma, Hepatitis, Ulcers and a Febrifuge	Anti-inflammatory, Antitumor, Antiviral, Antibacterial	Flavonoids,4-pyrrolidinyl, Ketone derivatives, and Pyrazole derivatives
Rhizophora mangle		Anticancer, Antitumor	Sulphur, Nitro-genus compounds
Rhizophora mucronata	Fever, Malaria, Cholera	Antiviral	Flavonoids, alkaloids, Sulphate Polysaccharides
Xylocarpus	Fever, Malaria,	Antifungal, Anticancer,	Alkaloids,

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granatum	Cholera	Antidiabetic	Flavonoids, Tannins, Saponins, Triterpenes.

II. Table 2: Mangrove Researched in Indonesia.[46]

Mangrove Species	Traditional Use	Recent Research Conducted on Mangrove	Chemical Compounds
Acanthus ilicifolius	Asthma, diabetes, hepatitis, skin disease, rheumatism	Antiviral, Antidiabetic	Alkaloids, Saponins,
Ceriops decandra	Hepatitis, Ulcers	Anticancer	Carotenoids, flavonoids, polyphenols, tannins, tri-terpenoids, phenolic compounds, and steroids
Rhizophora apiculata	Treatment of elephantiasis, hematoma, hepatitis, ulcers and a febrifuge	Anti-inflammatory, Antitumor, Antiviral, Antibacterial	Flavonoids,4-pyrrolidinyl, Ketone derivatives, and Pyrazole derivatives
Rhizophora mucronata	Fever, malaria, cholera	Antiviral	Flavonoids, Alkaloids, Sulphate polysaccharides
Xylocarpus granatum	Fever, Malaria, Cholera	Antifungal, Anticancer, Antidiabetic	Alkaloids, Flavonoids, Tannins, Saponins, Triterpenes.

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effective against pathogens. Secondary metabolites such as alkaloids, phenolic, st...

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Phytochemicals can be categorized as carotenoids, phenolics, alkaloids, flavonoid...

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Southeast Asia region has the most populated mangrove. Being the home to 30.9...

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likely have smaller water input, causing the increase in tissue salt on mangrove ha...

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on the microscope, mangroves potential in medical used are very promising that h...

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c.Mangroves as Anti-InflammatoryThe mangrove extracts have proved to be a pos...

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