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Bark as Medicine: A Systematic Review of Pharmacological Properties and Therapeutic Benefits of Medicinal Plant Barks

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Abstract - Plant bark, a multifaceted structure integral to the survival and function of woody plants, has long been recognized for its diverse pharmacological properties. This systematic review comprehensively explores the pharmacological effects and therapeutic potential of medicinal plant barks. The structure and chemical composition of plant bark are elucidated, shedding light on the intricate layers and tissues that contribute to its protective functions, nutrient transport, and environmental interactions. The pharmacological exploration encompasses a myriad of bioactive compounds found in plant barks, including alkaloids, phenols, tannins, flavonoids, terpenoids, and glycosides. The review synthesizes current knowledge on the major pharmacological activities associated with plant barks, emphasizing their anti-inflammatory, antimicrobial, antioxidant, antidiabetic, and antitumor properties. The anti-inflammatory potential of certain plant barks, exemplified by White Willow's salicin content, reveals promising avenues for addressing inflammatory conditions. Additionally, the antimicrobial efficacy of bark compounds, such as quinine from Cinchona trees and cinnamaldehyde from Cinnamon trees, positions them as valuable agents in combating infectious diseases. The antioxidant activity of phenolic-rich barks emerges as a crucial factor in mitigating oxidative stress-related disorders, while select barks show antidiabetic effects, offering potential interventions for diabetes management. Furthermore, the review explores the burgeoning field of research on plant barks with antitumor activity, presenting a promising frontier in the quest for novel anticancer agents.

Throughout history, diverse cultures have harnessed the medicinal benefits of plant barks, and this review bridges traditional remedies with contemporary scientific understanding. The collective findings underscore the rich pharmacological diversity housed within medicinal plant barks, inviting further research and exploration of their therapeutic applications in modern medicine.

Keywords - Plant Bark, Pharmacological Properties, Therapeutic Benefits, Bioactive Compounds, Anti-Inflammatory, Antimicrobial, Antioxidant

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INTRODUCTION

Plant bark is the protective outer covering of woody plants, serving as a dynamic interface between plants and their environment. It plays a crucial role in the survival, growth, and ecological interactions of various plant species. Bark consists of multiple layers and tissues, each with distinct functions and characteristics. Understanding the structure and composition of plant bark helps unravel its significance in plant physiology and ecosystem dynamics.Plant bark is composed of several layers, including the epidermis, cortex, cambium, phloem, and periderm. The outermost layer, the epidermis, is a thin protective layer that prevents excessive water loss and serves as the primary defense against pathogens and physical damage. Beneath the epidermis lies the cortex, a layer that provides mechanical support and stores carbohydrates and other nutrients. The cambium, a thin layer of meristematic tissue, is responsible for the production of new cells that contribute to plant growth in both girth and thickness. The phloem, a vascular tissue, transports sugars, organic compounds, and hormones throughout the plant. Lastly, the periderm is the outermost layer of bark that replaces the epidermis in older stems and trunks, offering protection and acting as a secondary barrier against water loss and pathogens.The chemical composition of bark varies among plant species but typically includes cellulose,

hemicellulose, lignin, and pectin. Cellulose provides structural support, while hemicellulose acts as a cementing material between cellulose fibers. Lignin, a complex polymer, imparts rigidity and strength to the bark, contributing to its resistance against mechanical stress and decay. Pectin, a polysaccharide, aids in cell adhesion and plays a role in water retention.One of the primary functions of bark is to provide protection to the underlying tissues of the plant. Bark acts as a physical barrier against mechanical damage from environmental factors such as wind, abrasion, and animal interactions. It also offers protection against herbivory by deterring or impeding the feeding activities of insects and larger herbivores. Furthermore, bark serves as a defense against pathogens, preventing the entry and spread of fungal and bacterial infections.

Plant bark plays a vital role in the transport and storage of nutrients. The phloem, present in the inner bark, facilitates the movement of sugars, hormones, and other organic compounds produced during photosynthesis from the leaves to other parts of the plant. It acts as a conduit for nutrient distribution, supplying energy and building blocks for growth and development. Bark also serves as a storage site for carbohydrates, water, and secondary metabolites, allowing plants to access reserves during periods of limited resource availability.

Bark contributes to the regulation of water movement within plants. It helps regulate transpiration, the process by which plants lose water through their leaves. Bark features, such as thickness, texture, and the presence of lenticels (small pores), influence water retention and loss. Bark adaptations, such as the development of cork layers, can minimize water loss in arid environments by reducing surface area and providing insulation against desiccation.

Bark acts as an interface for plant-environment interactions. It facilitates gas exchange, regulating the levels of carbon dioxide and oxygen in the plant tissues. The bark's permeability and porosity influence the diffusion of gases across its surface. Additionally, bark can modify the microclimate around the plant, creating a localized environment that affects temperature, humidity, and light availability.

The pharmacology of plant bark encompasses a vast array of species, each with its unique bioactive compounds and therapeutic properties. Throughout history, various cultures have utilized plant barks for their medicinal benefits. From traditional remedies to modern pharmaceutical research, the pharmacology of plant bark continues to intrigue scientists and healthcare professionals alike. In this extensive exploration, we will delve into the fascinating world of plant bark pharmacology, examining its diverse compounds, pharmacological activities, and notable examples.

Plant barks contain a rich assortment of bioactive compounds, including alkaloids, phenols, tannins, flavonoids, terpenoids, and glycosides. These compounds confer pharmacological effects that can be harnessed for therapeutic purposes. Let's explore some of the major pharmacological activities associated with plant barks:

Anti-Inflammatory Activity: Inflammation is a complex physiological response that plays a crucial role in various diseases. Several plant barks exhibit anti-inflammatory properties by inhibiting pro-inflammatory enzymes or modulating immune responses. For example, the bark of White Willow (Salix alba) contains salicin, which is converted to salicylic acid in the body. Salicylic acid is a precursor to aspirin and acts as a nonsteroidal anti-inflammatory drug (NSAID) with analgesic and anti-inflammatory effects.

Antimicrobial Activity: Many plant barks possess antimicrobial properties, making them valuable in the treatment of infectious diseases. The bark of Cinchona trees (Cinchona spp.) contains alkaloids, including quinine, which has been used to treat malaria for centuries. Quinine interferes with the growth and reproduction of the malaria parasite. Similarly, the bark of Cinnamon trees (Cinnamomum spp.) contains cinnamaldehyde, an active compound with antimicrobial activity against bacteria and fungi.

Antioxidant Activity: Oxidative stress, caused by an imbalance between free radicals and antioxidants in the body, plays a role in various chronic diseases. Plant barks rich in phenolic compounds, such as tannins and flavonoids, exhibit potent antioxidant activity. These compounds scavenge free radicals, reducing cellular damage and potentially mitigating the risk of diseases like cancer and cardiovascular disorders.

Antidiabetic Activity: Diabetes mellitus is a metabolic disorder characterized by impaired glucose regulation. Some plant barks have shown promising antidiabetic effects. For instance, the bark of *Ceylon Cinnamon* (Cinnamomumverum) contains bioactive compounds that enhance insulin sensitivity and improve glucose metabolism. This property has sparked interest in the potential use of cinnamon bark extracts or supplements in managing diabetes.

Antitumor Activity: The search for novel anticancer agents has led researchers to explore plant barks for potential antitumor activity. Numerous plant species have shown promising results in preclinical studies, highlighting their ability to inhibit tumor growth or induce apoptosis (cell death) in cancer cells. However, further research is necessary to uncover the specific mechanisms and potential clinical applications.

LITERATURE REVIEW

According to the findings of academic research, a significant proportion of communities throughout the world continue to choose traditional medicine as their preferred form of treatment. According to a scholarly source, roughly sixty percent of the population all over the globe and approximately eighty percent of the population in developing nations rely on botanical treatments for their healthcare needs [1]. The event that was discussed before may be attributed to a variety of factors, especially cost efficiency, ease of entrance, and acceptable price [2].

There is a long and well-documented history of people using different kinds of plants to cure different kinds of human illnesses. Many different components of plants, such as their leaves, stems, bark, and roots, are used in preventative, palliative, and curative treatments. Because the usage of "herbal remedies" is not in strict conformity with scientific procedures, mainstream medicine views them as a type of medicine that is complimentary to their practise. Herbal treatments are the basis for a significant number of the pharmaceutical medications that are now on the market and are recommended by medical professionals. Opium, aspirin, digitalis, and quinine are some examples of chemicals that have been used in medicine. In modern medicine, phytochemicals are substances that are often derived from higher plants and are used regularly. According to the results of the study, around eighty percent of the active components show a beneficial correlation between their present therapeutic use and their customary usage.

In modern times, there has been a rise in both the utilisation of and research into the development of medicines and nutraceuticals that are derived from botanical sources. Researchers from a wide variety of disciplines, including pharmacology, microbiology, botany, and phytochemistry, are now engaged in a broad study of the planet in order to uncover phytochemicals and other possible sources that may be used in the production of medications for the treatment of a wide variety of disorders. In order to identify medicinal plants that possess powerful therapeutic properties for the treatment of prevalent and common ailments such as malaria, diarrhoea, tuberculosis, pneumonia, and asthma, this study conducted a systematic literature review of electronic databases such as Google Scholar, SciFinder, and PubMed. The goal of this review was to locate information on medicinal plants.

There are several medicinal plants that have been scientifically shown to be effective against malaria.

Malaria is an illness caused by parasites that has a significant impact throughout the globe, particularly in nations that are still developing, and is one of the primary factors that contributes to death rates [4]. The ailment described above is pervasive in around one hundred developing nations and is responsible for between one million and two hundred thousand deaths annually in Africa [5]. Women who are pregnant and children who have not yet reached the age of five are the demographic groups who incur the greatest degree of damage as a result of this [6]. Due to the fact that a significant percentage of people who are afflicted with the condition are unable to pay standard pharmaceutical interventions [7], alternative treatments, which include the utilisation of various medicinal herbs, have become more popular. The development of drug resistance in malarial parasites to currently available antimalarial medications has sparked a search for other treatment medicines that are both effective and alternative. Due to the fact that medical plants have the capacity to create active substances such as quinine and artemisinin, one of the key focuses of study is the exploration of natural goods, more especially medicinal plants. The creation of antimalarial medications would not have been possible without the contribution of these substances. This is supported by the findings of a number of research [8, 9]. Many different plant species have been analysed by scientists to see whether or not they are effective in warding off the effects of malaria. In light of the substantial in vitro effectiveness shown by the succeeding botanical specimens, these specimens have been subjected to examination.

Cryptolepissanguinolenta; The plant genus Sanguinolenta (Lindl.) Schlechter belongs to the Apocynaceae family of plants in the botanical kingdom. A specific ingredient is referred to as "Ghana quinine" by the general public of Ghana, although the Asante and Ewe ethnic groups respectively refer to it as "Nibima" and "Kadze" [10]. The kind of plant that is being examined here is a shrub, and it has a thin stem. Its growth patterns are distinguished by twining and scrambling, so it is a very interesting example. This organism is native to the continent of Africa and is known to exhibit important ethnopharmacological qualities. The West African sub-region has shown a substantial amount of interest in this plant as of late. The plant has a long history of use in traditional medicine, particularly in the treatment of malaria, infections of the upper respiratory and urinary tracts, diarrhoea, hypertension, and as a wound-healing agent. Previous research [12, 13] has provided support for the facts presented here. The ethanolic and aqueous extracts obtained from *C. elegans*have both been shown to be effective via in vitro testing. have shown certain characteristics. The antiplasmodial activity of the chemical sanguinolenta was shown against the strain of Plasmodium falciparum (K1) that is known to be resistant to a variety of different medications. According to the results, the extracts had a strong inhibitory influence on the proliferation of the parasites. It was found that all of the extracts displayed an inhibition rate of at least 90% at doses that were lower than 23 µg/mL. The ethanol extracts obtained from the plant's roots and leaves both demonstrated a significant degree of efficacy, as shown by their respective IC50 values of 0.895 0.02 and 3.01 0.02 µg/mL. Both of these values were

much lower than 1. According to reference [14], the 50% inhibitory concentration (IC50) values for the aqueous extracts of roots and leaves were reported to be 2.32 0.3 and 13.5 0.7 µg/mL, respectively. The purpose of the current investigation is to examine the efficacy, from a clinical standpoint, of a tea bag formulation that contains C. In this study, people who had been diagnosed with uncomplicated malaria were used to test the effectiveness of sanguinolenta root. According to the results of the research, half of the patients had a reduction in the amount of *P. falciparum* parasitaemia in their blood after a period of 72 hours, and by the seventh day, all of the patients had seen a total reduction in their parasitemia. By the third day, all of the symptoms, including fever, chills, nausea, and vomiting, had subsided or disappeared entirely. According to the conclusions of a research study [15], the use of *C sanguinolenta* resulted in 93.5% of effective treatment outcomes for the patients being treated. An infusion of*sanguinolenta* was consumed three times each day for a period of five days in a row, and just one tea sachet was used for its preparation. Despite this, recrudescence was seen twice, once on the 21st day and once on the 28th day after the treatment began.

T. Ivorensis A. Chev., is the name of a specific species of plant in the botanical world, is a member of the Combretaceae family and is more popularly known by the name "black afara." Among the Asante people, the label of 'amire' is acknowledged as a valid option. The previously described species is a sizeable instance of a deciduous arboreal plant that has the ability to reach heights ranging from 15 to 46 metres. In many tropical nations, the cultivation of this species as a wood plantation is a common and widespread habit [16]. According to sources [17, 18], a common practise in traditional medicine is to use diverse plant components for the purpose of treating a variety of infectious diseases and conditions, including malaria, yellow fever, piles, stomach ulcers, wounds, and other infections. According to the findings of a study that was carried out by Komlaga et al. (2013), the aqueous leaf extract of T. repens was able to inhibit the growth of *T. brucei*. I*vorensis* showed significant antiplasmodial activity in vitro against both chloroquine-sensitive (3D7) and chloroquine-resistant (W2) strains of P. falciparum. Ivorensis was shown to be more effective against the chloroquine-resistant strain. The IC50 values for the extract were calculated to be 0.64 ±0.14 µg/mL and 10.52 ±3.55 µg/mL, respectively. In vitro antimalarial efficacy against chloroquine-resistant strains of Plasmodium falciparum was proven by an extract of ethanolic stem bark, as the results of a research investigation revealed. The result that was reported for the IC50 was 6.949 g/mL.

The botanical taxon that is referred to as *E.* guineensis Jacq. (*Arecaceae)* is the botanical name for the oil palm, classified as a member of the coccoid group of palms and is classed as a plant that falls within the monocotyledonous plant classification. The flora specimen has been seen to live for more than 100 years and has the potential to grow to a height of 15 metres. This organism may be found in a variety of locations in the tropical rainforest zone of West Africa [21], as its geographical range spans those places. The botanical taxon that is referred to as E. guineensis is most usually in practise in the treatment of a wide variety of medical ailments, including but not limited to gonorrhoea, rheumatism, headaches, and wounds [22]. According to the results of an anti-plasmodial activity test conducted in vitro, the ethanolic extract of *E. coli* may inhibit the growth of plasmodium parasites. In terms of antimalarial activity, the antimalarial properties of the leaves of guineensis have been shown to have remarkable effectiveness against chloroquine-resistant P. falciparum, demonstrating a high IC50 value of 1.195 µg/mL [20].

Traditional medicine makes frequent use of a plant species called *Phyllanthusemblica*, which is also referred to by its Latin name, *P. emblica L*. The plant in question belongs to the family Euphorbiaceae and has the features of a deciduous plant of modest size that has the potential to grow to a height of 10–18 metres. This particular species was originally found in the tropical Southeast Asia area, but now it may be found all over the globe in a variety of subtropical and tropical environments. The Indian gooseberry, also known scientifically as *Phyllanthusemblica*, is a kind of fruit that contains high amounts of vitamin C, minerals, and amino acids. It has been suggested in references 23 and 24 that these nutrients may help in the restoration of decreased levels of both energy and strength. The plant has a long history of use in traditional medicine, and has been put to use to treat a wide range of conditions, including diabetes, inflammation, asthma, cough, skin illnesses, peptic ulcer, intermittent fevers, leprosy, headache, dizziness, anaemia, scorpion-sting, and snakebite [25]. In order to evaluate the effectiveness of *P. emblica* as an anti-plasmodial agent, a fluorescent test based on SYBR green I was employed. The results of the research showed that the methanol leaf extract was very effective against CQ-sensitive (3D7) and CQ-resistant (Dd2 and INDO) strains of *P. falciparum*. [CQ] stands for chloroquine, which is a drug that is used to treat malaria. The IC50 values for the extract were found to be 3.125 µg/mL, 4.8 µg/mL, and 5 µg/mL, respectively. According to the results of a research investigation, the ethyl acetate leaf extract showed activity against 3D7, Dd2, and INDO P. falciparum strains, with IC50 values of 7.25 µg/mL, 15 µg/mL, and 9 µg/mL, respectively [26]. This extract also showed efficacy against INDO *P. falciparum strains*, with values of 9 µg/mL.

Cloves are also known by their scientific name, *Syzygiumaromaticum*. The plant that is more popularly known as "aromaticum". Clove comes from the plant *Eugenia caryophyllata*, which is a member of the Myrtaceae family and is known more popularly as clove. Merril and Perry state that clove is a very valuable and historically significant spice. Cumin is most often used as a flavouring agent in a wide variety of culinary preparations. It has been stated that cumin has medicinal capabilities such as

anthelmintic, anti-asthma, anti-inflammatory, antioxidant, antiviral, and anti-parasitic qualities [27]. Cumin is most commonly used as a flavouring ingredient in culinary preparations. In a research that Bagavan and his colleagues carried out, they demonstrated that an extract of *S. methanolica* had antimalarial activities. The flower buds of aromaticum are the topic that will be discussed in this article. According to the findings of the experiment, the IC50 value of the extract was determined to be 6.25, 9.5, and 10 µg/mL when tested against CQ-sensitive (3D7) and CQ-resistant (Dd2 and INDO) strains of *P. falciparum*, respectively.

*Goniothalamusmarcanii*which belongs to the family Annonaceae, is recognised as a synonymous designation by the nomenclature *G. tamirensis*Pierre ex Finet&Gagnep. The natural occurrence of the phenomena is noticed in the tropical and subtropical areas of Southeast Asia. According to reference 28, the extracts made with 80% ethanol demonstrated an in vitro antimalarial activity against the drug-resistant K1 strain of *P. falciparum*. The IC50 value for this activity was 6.3 µg/mL.

The plant species known as Casearia*sylvestris* belongs to the family of plants known as the Salicaceae, is a type of evergreen shrub or small tree characterised by its long, slender branches and dense, globose crown. This species typically reaches a height of 4-6 metres, although it has been known to grow as tall as 20 metres. It is widely distributed throughout South America. The utilisation of this substance in conventional medicine has been observed for the treatment of snake bites, wounds, inflammation, fevers, gastric ulcers, and diarrhoea [29]. The stem wood, stem bark, root bark, leaf, and root wood of *C. sylvestris* were subjected to hexane extraction, while the root bark was subjected to ethanol extraction. The resulting extracts were found to possess significant in vitro antiplasmodial activity against chloroquine-resistant strains. The FcB1/Colombia strain of P. falciparum has been found to exhibit IC50 values of 0.9 ± 0.2, 1.0 ± 0.4, 1.2 ± 0.4, 1.3 ± 0.1, 2.3 ± 0.5 and 7.7 ± 1.1 µg/mL, as reported in reference [30].

The *C. vernalis* is a species of *Cambess*. tree that is a member of the Sapindaceae family. It is semi-deciduous in nature and has an elongated, dense crown that can reach heights of 10-22 metres. This species of tree is distributed across various forest formations in South America, including Brazil, Argentina, Uruguay, Paraguay, and Bolivia.

The botanical name of a plant belonging to the Annonaceae family is *X. emarginata* Mart. The plant species is indigenous to the Cerrado biome of Brazil. The tree in question is characterised by an evergreen nature and a slender, nearly columnar crown. It has the potential to reach heights of 10-20 metres and diameters of 30-40 centimetres. The growth pattern typically involves the formation of extensive clusters, resulting in a uniform and cohesive mass. The species is typically found in swamp forests and is not known to thrive in arid environments. This substance finds its application as a condiment in culinary practises and as a carminative and aphrodisiac in traditional medicinal practises [32]. The extracts from the root bark and stem bark of *X. emarginata* were found to have inhibitory effects on *P. falciparum*, specifically the chloroquine-resistance FcB1/Colombia strains. The IC50 values for the root bark and stem bark extracts were 4.9 ± 0.2 and 5.2 ± 0.4 µg/mL, respectively, as reported in reference [30].

Xylopia aromatic is the African pepper, often known as Guinea pepper.This tree is native to the Cerrado grassland vegetation, more specifically in the eastern Brazilian states of Goiás and Minas Gerais. It is a medium-sized tree with lengthy, drooping branches that look similar to a Christmas tree. The leaves exhibit an alternate phyllotaxy and are narrow and pointed. They are arranged in a flat plane with regular spacing along the branches.

The scientific name for the cranberry is Vacciniummacrocarpon, but most people just call it cranberry. The Mart plant, which belongs to the Apocynaceae family, is a deciduous tree that can attain a height of 3 to 25 metres and a diameter of 25 to 35 centimetres, with an open crown. This species of tree is classified as a timber tree and is native to Brazil, Venezuela, Bolivia, Paraguay, and Peru.

A. indica is a botanical name used to refer to a specific species of plant. *A. Juss*, a member of the Meliaceae family, is commonly referred to as the neem tree or Indian lilac. The tree in question is a fast-growing evergreen that can attain a height of 15-20 metres, with some specimens reaching up to 35-40 metres. However, during periods of severe drought, the tree may experience significant leaf drop, with most or all of its leaves falling off. The crop is commonly cultivated in regions with tropical and semi-tropical climates. Neem has been found to exhibit efficacy against specific fungi that cause human infections, and is therefore utilised in the treatment of skin conditions such as eczema and psoriasis [34]. In vitro testing revealed that the 80% methanol leaf extract exhibited anti-plasmodial activity against both chloroquine and pyrimethamine sensitive strains, namely 3D7 strain, and chloroquine resistant and pyrimethamine sensitive Dd2 strain. The IC50 values for the two strains were 5.8 µg/mL and 1.7 µg/mL, respectively, according to a study cited as reference 35.

Harrisoniaabyssinica; Evergreen in appearance, H. abyssinicaOliv. is a member of the family Rutaceae and has the potential to develop into a spreading or much-branched tree. It is most commonly found in Tropical Africa, particularly in Sierra Leone, Cameroon, Sudan, Ethiopia, Uganda, Kenya, Angola, Zambia, and Mozambique [33]. Research has shown that the methanolic stem bark extract of this plant inhibits the growth of a chloroqu

Maytenussenegalensis; An example of this species is *M. senegalensis* Lam. Exell, which is a member of the family Celastraceae. African shrubs or trees that are widely distributed throughout Central and South America, Southeast Asia, Micronesia and Australasia, the Indian Ocean, and Africa. They can grow up to 15 metres high and have spines that are up to 7 centimetres long. Traditionally, it has been used as an anti-inflammatory herbal drug and is useful in the treatment of toothaches [36].

CONCLUSION

In conclusion, plant bark serves as a protective outer covering for woody plants and plays a crucial role in their survival, growth, and ecological interactions. It consists of several layers with varying chemical compositions. Bark is involved in the transport and storage of nutrients, regulation of water movement, gas exchange, and modification of the microclimate around the plant. Additionally, plant bark has significant pharmacological activities and has been used in traditional medicine for various ailments. Several plant species, including *T. Ivorensis A. Chev., E. guineensisJacq., Cloves, Goniothalamusmarcanii, Caseariasylvestris, C. vernalis, Xylopia aromatic, Vacciniummacrocarpon,* and *A. indica*, have been studied for their medicinal properties and have shown effectiveness against malaria and other diseases. Further research into plant bark and its therapeutic potential is ongoing.

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