

THE CHEMISTRY INSIDE SPICES & HERBS: RESEARCH AND DEVELOPMENT

VOLUME 6



Editors:
Pankaj Kumar Chaurasia
Shashi Lata Bharati

Bentham Books

The Chemistry Inside Spices & Herbs: Research and Development

(Volume 6)

Edited by

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Editors: Pankaj Kumar Chaurasia & Shashi Lata Bharati

ISSN (Online): 3041-0932

ISSN (Print): 3041-0967

ISBN (Online): 979-8-89881-306-2

ISBN (Print): 979-8-89881-307-9

ISBN (Paperback): 979-8-89881-308-6

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First published in 2026.

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FOREWORD

The book titled “**The Chemistry Inside Spices & Herbs: Research and Development (Volume 6)**” is a compiled work of a total of nine chapters, which have been written by experts in the field. Each chapter presents extensive discussions on the medicinal plants and explores detailed chemistry and pharmaceutical importance. International and national level experts are involved in writing the chapters, making it an excellent source for research and medicinal studies. The detailed scientific approaches to the medicinal plant genera, such as *Spondias*, *Taxus*, and *Momordica*, and species like *Anthocephalus cadamba*, *Murraya koenigii*, and *Aloe vera*, make this book noteworthy. The discussion on the role of tubulin-targeting biomolecules in oncology in chapter 7, the role of Indian spices in the treatment of Alzheimer’s disease in chapter 8, and the use of undervalued spices as flavoring agents and in therapeutic food in chapter 9 gives an attractive and medicinally striking appearance to this reference book.

This book will serve as an informative and excellent resource for researchers, scientists, academicians, students, and the medicinal industry in the fields of phytochemistry, Ayurveda, natural medicine development, and biochemistry.

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PREFACE

This book, **Volume 6** of the book series “**The Chemistry Inside Spices & Herbs: Research and Development**”, presents an extensive discussion and assessment of various plant genera and species, their chemistry, and medicinal applications. This volume contains nine chapters prepared by experts in the field. The book includes a comprehensive overview of phytochemistry and medicinal uses of *Spondias*, *Taxus*, *Momordica charantia*, *Anthocephalus cadamba*, *Murraya koenigii*, and *Aloe vera*. A detailed overview of biomolecules targeting tubulin, the use of various spices in the therapeutic management of Alzheimer’s disease, and the phytochemistry and utilization of underutilized spices as therapeutic food has also been provided.

Chapter 1, written by Salgado-Cepeda *et al.*, discusses the promising ethno-medicinal uses, phytochemistry, and pharmacology of the genus *Spondias*. This genus is a valuable resource for pharmacological and nutraceutical applications, with studies confirming its safety and efficacy. Its bioactive composition highlights its usefulness as a therapeutic and functional agent, expanding its applications in health and industry.

Chapter 2, written by Afrose *et al.*, expatiates on the phytochemistry and pharmacology of *Taxus*. Including such aspects provides a detailed discussion on all the other secondary metabolites in the plant, apart from the taxanes that are the primary bioactive compounds responsible for the anti-cancerous nature of the plant. The chapter further elaborates on the pharmacology of the *Taxus* extracts and characterizes constituents, including their actions on various forms of cancer. It also presents the difficulties in the conservation and reasonable use of *Taxus*, as well as the potential for accessing new drugs from this rich source.

Chapter 3, written by Kumari and Rakhra, presents an overview of the chemistry and medicinal applications of *Momordica*, especially *Momordica charantia* (bitter melon). The plant is rich in bioactive compounds, such as saponins, alkaloids, flavonoids, triterpenoids, and phenolic compounds, which contribute to its therapeutic potential. Pharmacologically, *M. charantia* exhibits significant antidiabetic, anticancer, antioxidant, anti-inflammatory, and antimicrobial activities.

Chapter 4, written by Samant *et al.*, presents an overview of *Anthocephalus cadamba*, encompassing its botanical characteristics, ethnobotanical significance, phytochemical composition, and medicinal applications.

Chapter 5, written by Dutta *et al.*, covers the phytochemical analysis of *Murraya koenigii*, its everyday practical applications for people, recent research applications, and potential future directions to enhance its accessibility and benefits for the general public.

Chapter 6, written by Kumar *et al.*, discusses the extraction methods, chemical properties, and pharmacodynamics responsible for the *Aloe vera* plant’s anti-inflammatory, antibacterial, antioxidant, and wound healing properties. Moreover, the chapter discusses the current and potential directions for the application of *Aloe vera* in clinical practice, as well as possible directions for further scientific investigations.

Chapter 7, written by Patel and co-authors, provides a comprehensive overview of biomolecules targeting tubulin, detailing their chemistry, molecular mechanisms, and therapeutic potential. It explores recent advances in the field and offers insights into the future prospects of these biomolecules. The chapter delves into the structure and function of tubulin,

a key protein in cell division, and explains how disrupting its function can effectively halt the proliferation of cancer cells. Additionally, it highlights the evolution of tubulin-targeting agents, from natural products to synthetic and semi-synthetic derivatives, and examines advancements in drug design and delivery systems aimed at enhancing specificity and minimizing toxicity, underscoring the potential of these agents in oncology.

Chapter 8, written by Adhikary *et al.*, offers a summary of the phytochemistry, biological and cellular activities, and potential therapeutic usage of various spices in the therapeutic management of Alzheimer's Disease.

Chapter 9, written by Bagul and Patel, presents the phytochemistry and medicinal properties of undervalued spices. Undervalued spices have nutritional importance and medical significance; in Ayurvedic medicine, they are valued for their medicinal properties. Hence, the present book chapter deals with phytochemistry and the utilization of underutilized spices as therapeutic food.

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CHAPTER 1

Genus *Spondias*: A Review of Ethnomedicinal Uses, Phytochemistry, Pharmacological Activities, and Geographical Distribution

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Abstract: The genus *Spondias*, belonging to the *Anacardiaceae* family, comprises about 18 species of trees and shrubs distributed in tropical and subtropical areas of America, Africa, and Asia. These species have notable ethnobotanical and pharmacological importance, as their fruits and other parts are used in food and traditional medicine to treat ailments, such as fever, pain, inflammation, diabetes, and digestive diseases. The species stand out for their rich chemical composition, which includes secondary metabolites, such as flavonoids, phenolic compounds, terpenoids, and essential oils. For example, *S. mombin* and *S. purpurea* contain phenolic acids (ellagic, gallic, chlorogenic), quercetin, and carotenoids, conferring antioxidant, anti-inflammatory, antimicrobial, and hepatoprotective properties. These characteristics support their use in treatments for metabolic disorders, gastric ulcers, and neurodegenerative diseases. In nutritional terms, fruits, such as cajá (*S. mombin*) and umbu (*S. tuberosa*) stand out for their high content of minerals, fiber, vitamin C, and bioactive compounds with antioxidant and lipid-regulating activity. On the other hand, leaf and root extracts of *S. tuberosa* and *S. pinnata* have antimicrobial, antidiabetic, and anti-fungal activities. In addition, *S. dulcis* and *S. purpurea* have antidiabetic potential and photoprotective properties, which are useful in cosmetics. The genus *Spondias* is a valuable resource for pharmacological and nutraceutical applications, with studies confirming its safety and efficacy. Its bioactive composition highlights its usefulness as a therapeutic and functional agent, expanding its applications in health and industry.

Keywords: Biological activity, Ethnomedicinal, Geographical distribution, Phytochemistry, *Spondias*, *Spondias mombin*.

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INTRODUCTION

The *Anacardiaceae* family comprises the *Spondias* genus, which includes approximately 17 species of trees and shrubs distributed throughout the tropical and subtropical regions of America, Africa, and Asia (Fig. 1) [1, 2]. According to the extant literature, species of this genus have been traditionally utilized to treat a variety of conditions, including fever, pain, inflammation, and digestive disorders [3, 4]. Beyond their medicinal applications, the fruits of *Spondias* are consumed fresh or used in the preparation of juices, jams, and other food products [5].

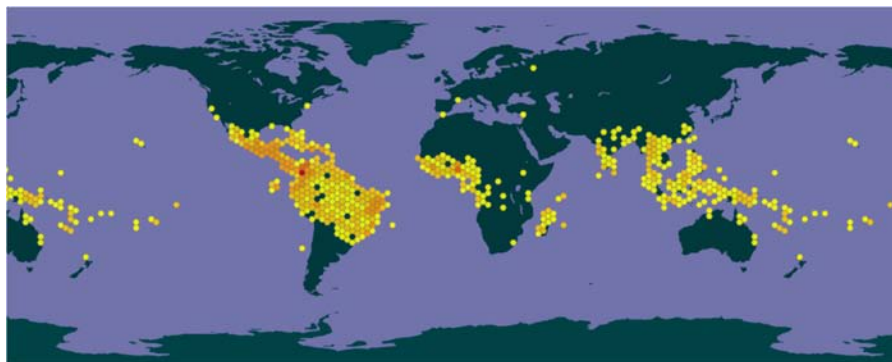


Fig. (1). Geographical distribution of genus *Spondias* around the world. Dots of different shades are observed, indicating the frequency with which it is reported (Photo: Global Biodiversity Information Facility).

The genus *Spondias* is characterized by trees and shrubs that can attain a height of up to 30 meters. The leaves are composed of 2-5 leaflets and can reach a length of up to 30 centimeters. The flowers are tiny, with a white or yellow hue, and are arranged in the form of panicles. The fruits are drupes, with a smooth surface and a pulp suitable for consumption [1 - 3, 5].

GEOGRAPHICAL DISTRIBUTION

The genus *Spondias* is widely distributed in tropical and subtropical regions of the world. Nine of its species are present in the Neotropics (Fig. 1), while others are located in certain areas of Africa and Asia [6, 7].

Among the most emblematic Neotropical species is *Spondias tuberosa*, endemic to Brazil, where it is predominantly found in semi-arid regions. Conversely, *Spondias mombin*, another native Brazilian species, is distributed in tropical regions, extending to southern Mexico and some Caribbean islands [8].

Another widely distributed species is *Spondias purpurea* L., which is native to Mesoamerica. It occurs from central Mexico to Peru and northwestern Brazil,

particularly in the Caatinga biome. It has also been documented in the natural savannas of Colombia and introduced in Florida and the Caribbean [9], as well as in various parts of Africa and Asia, where its introduction is more recent [10].

Spondias mombin has also been documented as an introduced species in Africa, particularly in the Afrotropical region. It is found in numerous countries, including Senegal, the Gambia, Guinea-Bissau, Sierra Leone, Liberia, the Ivory Coast, Ghana, Togo, Benin, Nigeria, Cameroon, the Democratic Republic of the Congo, Uganda, Kenya, Tanzania, Malawi, Mozambique, Zambia, Zimbabwe, Botswana, Namibia, and South Africa. It has also been reported in some Asian regions and western India [11 - 13].

In Asia, *Spondias pinnata* (L.f.) Kurz is found in India, Sri Lanka, and other Southeast Asian countries. Other species include *Spondias bipinnata* and *Spondias cytherea*, which are native to the Pacific Islands, and *Spondias lakonensis* and *Spondias laxiflora*, which are native to southern China, Laos, and Vietnam. These species have also been reported in Thailand [14 - 16].

TRADITIONAL USES OF GENUS *SPONDIAS*

The genus *Spondias* has been widely used in traditional medicine to treat various diseases, such as dementia, diarrhoea, diabetes, stomach pain, and anaemia.

Research reports that, in India, the fruit of *S. pinnata* is used to treat fever, ulcers, bronchitis, dysentery, and skin diseases. In addition, it is used to relieve joint and muscle pain, as well as to treat stomach problems, hyperacidity, and tuberculosis [17]. The powder of the ripe fruits is also used as an antidote against poisoned arrows. On the other hand, the bark of *S. pinnata* is used as a rubefacient for the treatment of joint pain and dysentery, as well as to prevent vomiting. A decoction of this bark is also used to treat gonorrhoea and to regulate menstruation. In Bali, the leaves of *S. pinnata* are used to treat diabetes [18, 19].

In Mexico, the fresh leaves of *S. purpurea* are used in infusion to treat flatulence and stomach pain, while, in decoction, they are useful against anemia, diarrhoea, dysentery, and skin infections. The bark of *S. purpurea*, also in decoction, is used for similar purposes [19]. The fruits of this species are used as antihistamines, antispasmodics, and diuretics, and the bark extract is used to treat stomach ailments [9].

In Bangladesh, *Spondias dulcis* G. Forst. is used to prevent eye infections and improve vision. In some regions of Africa, Asia, and America, this species is used to treat diarrhoea, and its fruits are indicated to relieve sore throats, internal ulcers, skin inflammations, and itching [19, 20].

Phytochemistry and Medicinal Properties of *Taxus*: Insight Overview

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Abstract: *Taxus*, scientifically known as yew trees, has emerged as a major research topic due to its rich phytochemical content and pharmacological activities. These plants are the storehouse for secondary metabolites, and taxanes are known to be the most potent compounds. In anticancer activities, taxanes, including Taxol, have been reported to have completely altered the treatment profile of cancer. Talking about the other medical benefits, the *Taxus* species contains anticancer features, as well as anti-inflammatory, anti-microbial, and neuroprotective activities. Nevertheless, instances of overexploitation have introduced conservation issues, stimulating the search for other ways of growing these and other taxanes and developing synthetics. This chapter expatiates on the phytochemistry and pharmacology of *Taxus*. It includes a comprehensive evaluation of secondary metabolites beyond taxanes, which also contribute to the plant's bioactive profile. The chapter further elaborates on the pharmacology of *Taxus* extracts and characterizes constituents, including their actions on various forms of cancer. It also presents the difficulties in the conservation and reasonable use of *Taxus* and the potential for accessing new drugs from this rich source.

Keywords: *Taxus*, Phytochemistry, Pharmacology, Taxanes, Anti-inflammatory, Anticancer.

INTRODUCTION

Over countless centuries, scientists have studied *Taxus* because its yew trees produce many secondary metabolites with strong medicinal value. As evergreen conifers, the *Taxus* species produces needle-shaped leaves and a bright red protective layer around its seeds, which contains taxanes having strong anticancer properties. Scientists found a new way to fight cancer when they extracted Taxol, an effective anti-microtubule agent, from the *Taxus brevifolia* plant [1 - 3].

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Traditional medicine systems have used different parts of *Taxus* plants across generations to treat pain, inflammatory diseases, and rheumatic disorders. Traditional herbal remedies combined with the discovery of Taxol created a strong demand for phytochemistry research in these remarkable plants. Scientists have studied how *Taxus* plants make their secondary metabolites, and they have examined the structure and function of these substances.

A thorough examination of the phytochemical makeup of *Taxus* species, along with their medicinal properties, is the focus of this chapter. Our analysis initiates by exploring the complex domain of phytochemistry to study the extensive spectrum of secondary metabolites that these plants generate. The authors study taxanes and a detailed examination of their biosynthetic pathways and structural patterns while describing the fundamental enzymes that construct them. The evaluation of *Taxus* also requires analytical methods that allow both compound identification and quantitative measurement because other significant secondary metabolites like alkaloids, flavonoids, and terpenoids potentially contribute to its pharmaceutical capabilities. The analysis of *Taxus* compounds involves the use of chromatographic and spectroscopic techniques along with mass spectrometric methods, as described in this chapter, and the following sections examine *Taxus*' phytopharmaceutical behaviors together with its chemical components. In detail, authors will analyze Taxol's anticancer functions along with other taxanes through investigations of their mechanisms of action, together with the existing clinical applications and current restrictions. The examination continues with an evaluation of taxanes' properties as well as additional *Taxus* extract compounds for treating various crucial medical conditions. An evaluation of taxanes' chemical properties will also be conducted to determine their anti-inflammatory mechanisms alongside antimicrobial potential and neuroprotective properties through relevant scientific findings. *Taxus* species face critical challenges owing to their limited natural distribution and slow growth rates, thus necessitating both preservation efforts and sustainable resource use [4 - 6]. Authors will analyze the difficulties of *Taxus* medicinal extraction while evaluating its negative effects on habitats [7, 8]. This will explore alternative approaches to get taxanes, such as semi-synthesis, plant cell and tissue culture, and genetic engineering. By providing a comprehensive overview of the phytochemistry and pharmacology of *Taxus*, this chapter will provide a deep understanding of the medicinally significant constituents beneficial for humans.

Phytochemistry of *Taxus*

Secondary Metabolites in Taxus

Taxus species warrant greater attention because they produce a large number of secondary metabolites with great medicinal properties [9 - 12]. Closely related

organic substances found in plants perform multiple essential ecological functions, like defending against plant predators and pathogens and attracting pollinators. *Taxus* displays complex secondary metabolite production patterns because genetic and environmental factors create an intricate pattern of compound diversity.

Secondary metabolites produced by *Taxus* have received recognition due to taxane compounds. The fused six-membered and four-membered ring systems produced by diterpenoids have strong anticancer effects [13 - 15]. The anticancer drug Taxol revolutionized cancer therapy through its unique mechanism of disrupting microtubule dynamics, and it remains the most renowned compound in its class.

Structural diversity in taxanes arises from multiple transformations throughout their side chains, while functional groups and stereochemical alignments also contribute to their overall complexity (Fig. 1). Key structural features include:

- **Taxane Skeleton:** The core structure consists of a bicyclic system incorporating an eight-membered ring fused with a four-membered oxetane ring, which is crucial for biological activity.
- **C-13 Side Chain:** Taxanes show different biological responses based on the side chain structures joined at position C-13 [16 - 18]. The presence of an ester side chain at C-13 is essential for the potent anticancer activity of paclitaxel.
- **C-7 and C-10 Positions:** The specific types of groups at these positions make Taxanes therapeutically significant, like baccatin III and cephalomannine.
- **Stereochemistry:** These compounds contain many chiral centers in their structure. Biological activities of these compounds depend highly on the structural arrangement of chiral centers.

While taxanes undeniably hold center stage, *Taxus* species produce a diverse array of other secondary metabolites with potential biological significance. These are shown in Table 1.

The production of secondary metabolites in *Taxus* serves various ecological functions, as shown in Table 2:

CHAPTER 3

Phytochemistry and Pharmacology of *Momordica*: Research and Development

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Abstract: The genus *Momordica*, a member of the family Cucurbitaceae, is a rich source of therapeutic compounds and has garnered scientific interest due to its wide array of bioactive constituents. *Momordica charantia* (bitter melon) has been extensively studied for its antidiabetic, anticancer, antioxidant, anti-inflammatory, and antimicrobial effects. These pharmacological benefits are largely attributed to its constituents, such as saponins, alkaloids, flavonoids, and triterpenoids. Moreover, the plant holds traditional significance for treating conditions such as diabetes, skin disorders, and gastrointestinal issues. This chapter provides an integrative overview of the phytochemical composition, biological activities, and therapeutic applications of *Momordica*, while also highlighting avenues for future research into its clinical and pharmacokinetic properties.

Keywords: Antidiabetic, Antioxidant, Bitter melon, Pharmacology, Phytochemistry,.

INTRODUCTION

The family Cucurbitaceae, commonly known as the cucumber or melon family, encompasses approximately 120 genera and nearly 965 species that are predominantly distributed across tropical and subtropical regions of the world [1]. Among its economically and medicinally important genera are *Bryonopsis*, *Citrullus*, *Cucurbita*, *Luffa*, *Momordica*, and *Trichosanthes* [2]. Within this family, the genus *Momordica* comprises about 60 species, including *M. balsamina*, *M. charantia*, *M. cochinchinensis*, and *M. foetida*. These species are native to the warm tropical zones of Africa and Southeast Asia and are known for their nutritional and therapeutic properties. The name *Momordica* originates from

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the Latin word “mordeo,” meaning “to bite,” which may allude to the serrated appearance of the plant’s seeds and leaves or to the distinctly bitter taste of its fruit [3].

Among the species in this genus, *Momordica charantia*—commonly known as bitter melon or bitter gourd—has gained the most scientific and ethnobotanical attention. It is a tropical and subtropical vine widely cultivated in regions such as South and Southeast Asia, China, Africa, and the Caribbean for its edible fruit, which is notably one of the most bitter among vegetables [4]. Morphologically, the plant is a fast-growing, tendril-bearing vine with grooved stems and soft, fleshy fruit. It thrives by climbing on supports and displays distinct diurnal flowers.

Kingdom: Plantae

- Order: Cucurbitales
- Family: Cucurbitaceae
- Genus: *Momordica*
- Species: *M. charantia*

From a reproductive biology perspective, *M. charantia* exhibits monoecious flowering with a tendency toward protandry, where male flowers mature and release pollen before the female flowers become receptive. This strategy promotes cross-pollination and thus enhances genetic diversity [5 - 7]. The male flowers produce nectar continuously, attracting insect pollinators such as bees, whereas non-nectariferous female flowers develop into fruits upon successful pollination. Fruit formation may occur *via* self-pollination or through cross-pollination, the latter being more advantageous in maintaining vigor and diversity in plant populations.

The subsequent sections of this chapter delve into the nutritional composition, phytochemical profile, pharmacological activities, and therapeutic potential of *M. charantia*, offering a holistic understanding of its relevance in both traditional and modern medicine.

NUTRITIONAL COMPOSITION

Among all the cucurbits, *Momordica charantia*, commonly known as bitter melon or bitter gourd, stands out for its remarkable nutritional value. More than just a traditional vegetable, bitter melon is esteemed for its dense composition of carbohydrates, proteins, fibres, vitamins, and essential minerals, which are key contributors to a balanced and health-promoting diet. With approximately 93.2%

water content, it qualifies as a low-calorie food, yet the remaining dry matter, rich in proteins and lipids (around 18.02%), delivers substantial nourishment in concentrated form.

The green, edible portion of bitter melon is particularly prized for its abundant supply of vitamins crucial for skin health, immune function, and antioxidant defense. Notably, it contains high levels of vitamins A, C, and E, which not only help in neutralizing free radicals but also support vital physiological functions. In addition, *M. charantia* is a powerhouse of B-complex vitamins, especially thiamine (B1), riboflavin (B2), niacin (B3), and folate (B9), which facilitate energy metabolism and red blood cell formation, thereby maintaining nervous system integrity.

Beyond its vitamin spectrum, bitter melon is an excellent source of essential minerals. It delivers potassium for cardiac and muscular performance, calcium for strong bones and teeth, zinc to enhance immunity and wound healing, magnesium for neuromuscular coordination, phosphorus for cellular energy and structural support, and iron for efficient oxygen transport in the blood.

Equally significant is its dense concentration of bioactive phytochemicals, which lend the fruit a high antioxidant potential. Compounds such as phenolics, flavonoids, isoflavonoids, terpenes, anthraquinones, and glucosinolates work synergistically to mitigate oxidative stress by neutralizing free radicals. This activity is thought to reduce the risk of chronic diseases, including cancer, diabetes, and cardiovascular conditions. Given its rich nutritional and phytochemical profile, *M. charantia* is increasingly recognized as a potent functional food, so much so that many cultures now regard it as a “superfood” for promoting holistic health and well-being [8].

PHYTOCHEMISTRY

Momordica charantia (bitter melon) is renowned not only for its nutritional profile but also for its diverse array of bioactive compounds that confer significant therapeutic potential. The plant contains an impressive range of chemical constituents, including proteins, fatty acids, sterols, volatile oils, and glycosides, which are distributed throughout its fruits, leaves, and seeds and contribute to its wide-ranging medicinal uses [9]. Notably, its fruit and leaves contain alkaloids such as momordicine, which have been linked to various pharmacological benefits. Saponin-like substances, glycosides, aromatic volatile compounds, mucilage, and adhesive-like chemicals also contribute both to its bitterness and medicinal potency.

CHAPTER 4

Unlocking the Medicinal Potential of *Anthocephalus cadamba*: A Phytochemical and Pharmacognostic Perspective

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Abstract: *Anthocephalus cadamba*, a revered evergreen tree, has garnered significant attention within the realm of medicinal plants due to its rich composition of phytochemicals and secondary metabolites. These constituents contribute to its therapeutic efficacy and nutritional value. It is a member of the Rubiaceae family and has references in ancient Vedic texts. It is native to various regions, including Australia, China, India, Indonesia, Malaysia, the Philippines, Singapore, and Vietnam. This tree has been extensively cited in Indian medicinal literature. In Ayurvedic medicine, *A. cadamba* is utilized for its therapeutic properties. Beyond its medicinal significance, *A. cadamba* also holds profound religious importance. The Kadam tree holds sacred significance in relation to Lord Krishna, earning it the alternate name Haripriya, denoting its status as a divine favorite. Traditionally, the Kadam tree has been utilized in the treatment of numerous health conditions, encompassing diabetes, diarrhea, anemia, uterine complaints, fever, stomatitis, gastric disturbances, inflammation, colds, infections, wounds, and snake bites. *Anthocephalus cadamba* exhibits a range of pharmacological properties, including astringent, febrifuge, antiseptic, and diuretic activities. Traditionally, it has been employed to enhance lactation in nursing mothers and improve semen quality in males. The plant's bioactive constituents have been found to possess antioxidant, antitumor, hypolipidemic, analgesic, and antiepileptic properties, as well as immunomodulatory effects. This chapter provides an overview of *Anthocephalus cadamba*, encompassing its botanical characteristics, ethnobotanical significance, phytochemical composition, and medicinal applications.

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Keywords: *Anthocephalus cadamba*, Ethnobotany, Haripriya, Kadamba, Pharmacological activities, Phytoconstituents.

INTRODUCTION

Overview of *Anthocephalus cadamba*

Ancient cultures recognized the healing potential of plants and used them to create medicines that have been passed down through generations, laying the foundation for modern pharmacology [1]. In recent years, herbal remedies have gained popularity in developing nations, where they are valued for their perceived safety and minimal side effects [2].

Nature has long been a source of healing for humanity. Medicinal plants are used to develop new treatment options. Many countries rely heavily on traditional medicine. This approach to healthcare is not only effective but also offers a sustainable and environmentally friendly solution [3]. *Anthocephalus cadamba*, or Jabon, is a valuable tree species renowned for its medicinal properties and economic significance. It belongs to the Rubiaceae family. This species has been extensively utilized in traditional medicine and is widely distributed across tropical and subtropical areas. In traditional medicine, it has been utilized for various purposes, including managing diabetes, diarrhea, fever, and inflammation, as well as treating wounds, ulcers, and snake bites [4]. *Anthocephalus cadamba* is referred to by multiple names, including “Kadamba” in Sanskrit and Hindi, as well as “Kodom” in Bengali. This evergreen tropical species is indigenous to various regions of Asia [5]. The diverse parts of the Cadamba plant have been investigated for their pharmacological effects, revealing a broad spectrum of biological activities. These include antidiabetic, antioxidant, antitumor, and anti-inflammatory properties, as well as nephroprotective, diuretic, and laxative effects. Furthermore, the plant has demonstrated antihepatotoxic, hypolipidemic, analgesic, and antipyretic activities, highlighting its potential in addressing various health disorders. Research has identified the plant's therapeutic potential in managing conditions, such as filariasis, malaria, epilepsy, and urolithiasis. Additionally, the Cadamba plant exhibits immunomodulatory, antivenom, gastroprotective, anthelmintic, and wound healing properties [6].

Botanical Description

Anthocephalus cadamba, commonly referred to as Kadamba, is a medicinal plant of considerable importance, boasting an array of distinctive botanical characteristics. It is a plant with medicinal and economic value. The Rubiaceae family, comprising over 600 genera and more than 13,000 species, is renowned for its rich biodiversity and numerous benefits. *Anthocephalus cadamba* is native

to tropical and subtropical regions, with a significant presence in India and other parts of the world. Its remarkable adaptability to diverse environmental conditions has enabled it to thrive in these areas, underscoring its ecological significance. Characteristically, this species grows into a sizable tree, often reaching impressive heights of up to 30 meters. *Anthocephalus cadamba* has a distinctive straight trunk, along with a broad, rounded crown that renders it a striking presence in its natural environment. Its leaves, arranged oppositely on the stem, exhibit an elliptical shape and can reach lengths of up to 20 cm [4]. The stems of younger trees exhibit a distinctive greyish-green hue, featuring smooth bark that gradually transforms into a rough, grey texture with age, characterized by prominent longitudinal fissures. The flowering period occurs between August and October, during which time the terminal globose heads display vibrant orange to yellow hues, emitting a fragrant aroma. The numerous fruitlets contain hollow or solid structures, while the seeds exhibit trigonal or irregular shapes [7]. The dark green, glossy foliage facilitates efficient photosynthesis, contributing to the plant's overall vitality. The flowers, though small, emit a fragrant aroma and typically display yellow or white hues, arranged densely in globular clusters. The unique arrangement of flowers on *Anthocephalus cadamba* proves highly attractive to various pollinators, thereby enhancing the plant's reproductive success, particularly during the rainy season. The fruit produced by the plant is a small, rounded, fleshy drupe, containing multiple seeds. These fruits play a crucial role in seed dispersal, as they entice animals to consume them, facilitating the spread of the species to new areas. As a key component of its ecosystem, *Anthocephalus cadamba* fulfills a vital function by offering shelter and sustenance to a diverse range of wildlife species. Moreover, its medicinal attributes and traditional applications amplify its significance, rendering it a valuable resource in both ecological and cultural spheres [4].

TRADITIONAL USES AND ETHNOPHARMACOLOGICAL SIGNIFICANCE

Historical Context and Cultural Importance

Anthocephalus cadamba holds a revered position in Indian culture, deeply intertwined with spiritual practices and regarded as a sacred entity. Its association with Lord Krishna, earning it the name 'Haripriya,' further amplifies its significance in local traditions and customs [6].

Ancient cultures believed the universe was made up of five core elements. This concept was thought to be the foundation of all life, connecting every living thing. The positions of celestial bodies were also believed to influence human lives. A long-held tradition suggests that certain plants have the power to counteract

Multipurpose Plant - *Murraya koenigii*

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Abstract: *Murraya koenigii*, an aromatic tropical and sub-tropical plant belonging to the Rutaceae family, is valued for its culinary, medicinal, and industrial applications. Its fresh leaves contain 23.73% alkaloids, 1.24% flavonoids, 8.74% saponins, 4.4% phenolics, 5.2% tannins, and some volatile oils, while the stem bark and roots yield carbazole alkaloids and triterpenes with notable medicinal properties. *Murraya koenigii* exhibits a broad spectrum of biological activities, including anti-inflammatory, cytotoxic, antidiabetic, antimicrobial, anticancer, antioxidant, anthelmintic, and hepatoprotective effects. Polyherbal mouthwashes with *Murraya koenigii*, *Acacia nilotica*, *Psidium guajava*, and *Eucalyptus* hybrid effectively prevent dental issues such as caries and plaque-induced gingivitis. Additionally, crude extracts from its leaves provide benefits like lipid-lowering, anti-diabetic, anti-diarrheal, and antihypertensive properties, and the whole plant is valued for treating bronchial respiratory problems, reducing cholesterol, and enhancing digestion. The oil of *Murraya koenigii* leaves has shown remarkable cholinesterase inhibitory activity, and its derivatives exhibit significant pharmacological activities, including anticarcinogenic, proapoptotic, antiangiogenic, and neuroprotective effects, which help alleviate oxidative stress, neurotoxicity, and cognitive dysfunction. It is evident that *Murraya koenigii* plant extract is very promising for the synthesis of metallic nanoparticles, with optimized conditions, including reaction time, pH of the solution, temperature, etc. Despite its advantages, large-scale nanoparticle production faces challenges related to repeatability in physio-chemical properties and toxicity, necessitating further research into optimizing and quantifying essential phytochemical constituents and metallic precursors, as well as assessing the toxicity of the final products. This chapter covers the phytochemical analysis of *Murraya koenigii*, its everyday practical uses for people, recent research applications, and potential future directions to enhance its accessibility and benefits for the general public.

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Keywords: Culinary applications, Morphological characteristics, Pharmacological properties, Phytochemical composition, Traditional medicine.

INTRODUCTION

India is rich in a variety of medicinal plants, many of which have been integrated into the diets and traditional healing practices of its diverse tribes. One of the most prominent medicinal plants in India is *Murraya koenigii* (L.) SPR., commonly used in daily food preparations and valued by Indian healers for centuries. This plant is also known by other botanical names, including *Bergera koenigii* (L.). Locally, it is referred to as curry neem, kari patta, sweet neem, or mitha neem. Originating in Asia, particularly in Sri Lanka, Bangladesh, and India, curry leaves are not only known for their culinary uses but also for their impressive nutritional content, rich in essential phytochemicals, minerals, and trace elements [1].

Taxonomy

The taxonomic classification of *Murraya koenigii* is as follows:

- **Kingdom:** Plantae
- **Sub-kingdom:** Tracheobionta
- **Super division:** Spermatophyta
- **Division:** Mangoliophyta
- **Class:** Mangoliopsida
- **Sub-class:** Rosidae
- **Order:** Sapindales
- **Family:** Rutaceae
- **Genus:** *Murraya*
- **Species:** *Koenigii* L. SPR [2].

VERNACULAR NAMES OF CURRY LEAF

Curry leaf plants are known by various names around the world. Some of these are listed in Table 1.

Table 1. Vernacular names of curry leaf [3].

Languages	Name of Curry leaves
French	Feuilles de curi
German	Curry blatter
English	Curry leaves

(Table 1) cont....

Languages	Name of Curry leaves
Chinese	Ga Lei Yihp
Dutch	Kerriebladeren
Spanish	Hoja
Hindi	Kathnim, Mitha Neem, Kurry Patta, Gandhela, Barsanga, Kari Patta
Orissa	Bassan, Basango, Bhursang, lesinga
Telugu	Karepaku
Tamil	Karuveppilei, Kattuveppilei, Karivempu, Kariveppilai
Assam	Narasingha, Bishahari
Malayalam	Kariveppilei
Kannada	Karibevu
Gujarati	Gorenimb, Kadhilimbdo
Bengali	Barsanga, Kartaphulli Gandhela
Sanskrit	Surabhinimba, Kalasaka, Mahanimb
Kashmiri	Mitha neem, Gandhla, Gandhela, Gandhe

HISTORY

Curry leaves are India's most significant medicinal plant, used by people on a daily basis. From ancient times, it was used as a herbal tonic and as a laxative for diarrhea, dysentery, and piles. The leaf, stem, fruit, and root parts of this plant are widely used for many applications, including culinary and medicinal purposes. It is spread throughout all the tropical regions of India except the Himalayas. Apart from India, it is also found in Sri Lanka, Bangladesh, and the Andaman. The use of curry leaves can be dated back to ancient times and is included in Indian Ayurveda, Siddha, and Unani literatures. In food, curry leaves are used as spices by frying them in oil, mostly for their aromatic flavor. As medicine, they have been used to strengthen gums and fight tooth infections, nourish hair by extracting its oil, and treat skin problems like infections, wounds, and burns by making a paste from leaves and leaf juice. This paste is also used to treat many stomach and hepatic issues. The curry leaf (*Murraya koenigii*) is native to the Indian subcontinent, including the Andaman and Nicobar Islands, Sri Lanka, and Bangladesh. It later spread to various parts of the world, primarily through Indian migration. Today, it is cultivated in tropical and subtropical regions, including India, Sri Lanka, Bhutan, Nepal, Malaysia, southern China (Guangdong, southern Hainan, and southern Yunnan), Laos, Vietnam, Thailand, the Mariana Islands, Vanuatu, New Caledonia, the Ryukyu Islands, Australia, and South Africa.

CHAPTER 6

A Comprehensive Assessment of the Phytochemistry and Pharmacology of *Aloe vera*

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Abstract: *Aloe vera* is a specific type of plant from the subclass of Aloe succulents, most admired across generations for its medicinal and curative properties. This chapter reviews the phytochemistry and pharmacology of *Aloe vera*, its bioactive compounds, and its pharmacological efficiencies. *Aloe vera* contains a wide phytochemical profile with numerous polysaccharides, glycoproteins, anthraquinones, active vitamins and minerals, and enzymes, all of which are vital to the manifold curative effects of aloe. This chapter discusses the extraction methods, chemical properties, and pharmacodynamics responsible for the anti-inflammatory, antibacterial, antioxidant, and wound-healing properties of the plant. Moreover, this chapter explores the current and potential applications of *aloe vera* in clinical practice, as well as potential directions for further scientific investigation. In this chapter, an attempt has been made to review and discuss a wealth of information on the various benefits of *aloe vera* by synthesizing both folklore uses and modern pharmacological perspectives.

Keywords: Aloe vera, Bioactive compounds, Clinical applications, Pharmacodynamics, Wound healing properties.

INTRODUCTION

Aloe vera (*Aloe barbadensis miller*) is a succulent xerophyte originating from North Africa that has been used to treat ailments for over 2000 years. It grows vigorously and has thick, fleshy leaves that contain a clear, transparent gel substance known as aloe vera gel, which has a wide range of therapeutic uses

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worldwide. Chiefly used as an effective topical herbal therapy and natural remedy for ailments, *aloe vera* has been an important part of the traditional medicine systems of various ancient civilizations that are still in practice even in today's modern world of pharmacies and high-tech medical technologies [1]. The historical context of *A. vera*, with a special focus on the traditional uses of the plant, forms the background of this chapter, providing a more profound understanding of some of the phytochemical and pharmacological properties associated with the plant [2].

HISTORICAL BACKGROUND AND TRADITIONAL USES OF ALOE VERA

Aloe vera (*Aloe barbadensis* Miller) is a succulent plant native to arid regions and has been historically associated with North Africa that has been documented for its medical use for over 2000 years. It is a fast-growing plant with thick, green, fleshy leaves and a clear gel substance known as *aloe vera* gel, which has many medical uses worldwide. Traditionally used externally as a topical herbal remedy for a range of ailments, *aloe vera* is one of the medicinal plants that supported the extensive healthcare practices of earlier civilizations, long before the advent of modern pharmaceuticals and advanced biomedical technologies. This forms the background of this chapter from a historical perspective and a special reference to the traditional uses of the plant to provide a much better appreciation of some of the phytochemical and pharmacological aspects of the plant [3].

PHYTOCHEMISTRY OF ALOE VERA: MAJOR BIOACTIVE COMPOUNDS

Polysaccharides

Polysaccharides are considered bioactive compounds among all the ingredients present in *Aloe vera* and play a vital role in enhancing the therapeutic value of *Aloe vera*, particularly in the wound-healing process, immunomodulatory action, and anti-inflammatory effects. The organic gel of *aloe vera* contains polysaccharides, of which acemannan is considered a critically studied and major molecule. Acemannan is a linear polysaccharide with a high molecular weight that contains mannose units as the monomers. It has immunomodulatory properties that are presumed to enhance the function of macrophages and increase cytokine synthesis. This compound improves the healing rate by increasing the population of fibroblasts and improving collagen synthesis, making it highly useful for the treatment of burns, cuts, and other dermal injuries. Other polysaccharides, such as *Aloe vera*, are composed of glucose, galactose, and arabinose, which add to the medicinal usefulness of the plant. Such polysaccharides help retain water and exhibit sedative properties when used in

external applications [4]. It has been established that polysaccharides found in *aloe vera* are useful in reducing inflammation, killing bacteria, and preventing oxidation. It is believed that the action of the substance is due to the stimulation of overactive immune cells, T-lymphocytes, macrophages, neutrophils, and others. Immune-modulating functions also aid in the treatment of numerous diseases and skin disorders [5].

Anthraquinones

The next group of bioactive chemicals found in *A. vera* latex are anthraquinones. These chemicals are well known as purgatives with higher activity and, at the same time, possess antibacterial, anti-inflammatory, and anticancer activities. Aloin is the predominant anthraquinone glycoside constituent in *Aloe vera* latex. It is a potent cathartic that acts via the stimulation of peristalsis in the alimentary canal [6]. In addition to its purgative ability, aloin exhibits antibacterial properties, and studies have shown that it can control gram-positive and gram-negative bacteria. Aloin demonstrated anticancer potential in the present study, successfully inhibiting the growth of various cancer cells. Emodin, an active anthraquinone isolated from *Aloe vera*, has therapeutic effects that include anti-inflammatory, antioxidant, and anticancer effects. Emodin has already been shown to inhibit the activation of many pro-inflammatory signaling molecules like NF- κ B and reduce the production of inflammatory cytokines [7]. Additionally, emodin has been recognized as a possible cancer-fighting agent because it causes death of cancer cells, especially those from colon, liver, and lung cancers. Owing to its anti-inflammatory and antioxidant properties, emodin can be used to treat disorders such as arthritis and inflammatory bowel diseases [8].

Similarly, derivatives such as aloin and emodin possess advantageous therapeutic profiles; nevertheless, their purgative effect limits their use in certain formulations, especially for topical or internal use. Presumably, the chemicals mentioned earlier are removed or reduced in *aloe vera* compositions, especially those intended for use in body lotions, cosmetics, and dietary products [9].

Vitamins and Minerals

Aloe vera is a good source of many important vitamins and minerals that contribute to its wound-healing properties. *Aloe Vera* contains an assortment of vitamins. These vitamins include Vitamin A, C, E, and the B-vitamin complex, which includes B vitamins [10].

Tubulin-Targeting Biomolecules: Pioneering Strategies in Oncology

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Abstract: The development of tubulin-targeting biomolecules as anticancer agents has been widely studied, and a variety of drugs are being clinically used and others are being tested, including paclitaxel, docetaxel, laulimalide, peloruside, ixabepilone, patupilone, vinblastine, vincristine, vinorelbine, vinflunine, colchicine, combretastatin, and 2-methoxy estradiol. These agents target four distinct binding sites: laulimalide, taxane/epothilone, *vinca* alkaloid, and colchicine. The dynamics of microtubule polymerization have been identified as fascinating and well-established targets in cancer therapy, since microtubule polymerization greatly impacts crucial processes, such as mitosis. This chapter provides a comprehensive overview of biomolecules targeting tubulin, detailing their chemistry, molecular mechanisms, and therapeutic potential. It explores recent advances in the field and offers insights into the future prospects of these biomolecules. This chapter describes the structure and function of tubulin involved in cell division, and how blocking its function can effectively inhibit cancer cell growth. Moreover, it discusses how tubulin-targeting agents have advanced from natural products to synthetic and semi-synthetic derivatives in recent years, and examines how drug design and delivery systems have improved specificity and minimized toxicity, thus highlighting their potential as oncology therapies.

Keywords: Anticancer, Colchicine, Epothilone, Laulimalide, Microtubule, Microtubule-targeting agents, Taxol, *Vinca* alkaloid.

INTRODUCTION

Cancer is a major global health concern that necessitates research into novel therapeutic targets and approaches. A wide range of naturally occurring, semi-

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synthetic, and synthetic antimetabolic medications is among the many possible molecular targets for selective therapeutic intervention that have been identified by extensive research into tumor biology and its biochemical processes. One of the most promising and well-established targets for anticancer therapy is microtubules [1, 2]. The dynamics of microtubule polymerization are crucial for essential cellular processes, such as mitosis and cell signaling, making them a potential target for disrupting cancer cell proliferation. One of the most important cancer targets discovered so far is microtubule inhibitors, which have been used as cancer treatments for years [1 - 4].

The Role and Purpose of Microtubules

Microtubules are composed of α - and β -tubulin heterodimers that come together to form protofilaments longitudinally. Thirteen protofilaments align laterally to form a cylindrical structure with an outside diameter of roughly 25 nm. The α - and β -tubulin subunits possess unique binding sites for nucleotide exchange, with GTP associated with β -tubulin during microtubule assembly. The polarized nature of microtubules arises from the structural and functional differences between the plus (+) and minus (-) ends. The β -tubulin subunits at the plus end undergo GTP hydrolysis and are more dynamic, while the α -tubulin subunits at the minus end are relatively stable [5 - 7].

Functions of Microtubules

Cellular Organization

Microtubules play an important role in providing cellular structure, maintaining cell shape, and organizing cellular components. Cellular polarity is established by a network of pathways that anchor organelles and the cytoplasm.

Intracellular Transport

Microtubules facilitate intracellular transport by motor proteins such as kinesin and dynein throughout the cell. Motor proteins attach to microtubules and utilize ATP hydrolysis to travel along the filament, transporting vesicles, organelles, and various cellular components.

Cell Division

Microtubules play a crucial role in cell division, particularly during cytokinesis and mitosis. They make up the complex structure known as the mitotic spindle, which ensures accurate chromosomal segregation to daughter cells.

Cell Motility

Microtubules facilitate cell movement through interactions with motor proteins and participate in the development of cellular extensions, including lamellipodia and filopodia, which are crucial for cell migration and invasion.

Cellular Signaling

Microtubules are involved in cell signaling pathways by interacting with signaling molecules and regulatory proteins. Additionally, they might serve as scaffolds for the construction of signaling complexes [8 - 11].

Microtubule Dynamics and Regulation

Microtubule function is controlled by a variety of stimuli, including microtubule-associated proteins (MAPs), post-translational modifications, and small molecules. MAPs can either stabilize or destabilize microtubules, facilitate or hamper polymerization, and crosslink microtubules into bundles. Post-translational changes involving phosphorylation, acetylation, *etc.*, can modify the nature of tubulins and further influence the dynamic nature of the microtubules. Some small chemicals, such as taxol and colchicine, can bind with tubulin, interfering with either microtubule assembly or disassembly [11 - 15].

MICROTUBULES AND CANCER: RATIONALE FOR TARGETING

The interruption of microtubule dynamics has been associated with the onset and progression of cancer. Abnormalities in microtubule assembly, disassembly, and organization result in uncontrolled cell division, chromosomal instability, and the development of abnormal mitotic spindles. There is a reason why microtubules have been targeted for cancer therapy. Microtubules play an essential role in cell division, possess unique structural properties, and are amenable to pharmacological intervention [16 - 18]. Microtubule-targeting drugs can disrupt mitosis and hamper tumor proliferation by either stabilizing microtubules to avoid depolymerization or destabilizing them, resulting in aberrant spindle formation and cell cycle arrest. These medicines have exhibited effectiveness against a diverse array of cancer types and have been extensively utilized in clinical practice (Table 1). Recent advancements in innovative microtubule-targeting medicines and the investigation of combination therapy have broadened the therapeutic alternatives for cancer treatment. Moreover, comprehending the causes of resistance to microtubule-targeting drugs and formulating strategies to surmount this resistance are essential for enhancing treatment outcomes [16 - 19]. Microtubules, dynamic cytoskeletal proteins, are essential for numerous cellular functions, including cell division, intracellular transport, and the preservation of

Futuristic Approach towards Treatment of Alzheimer's Disease (AD) through Indian Spices: Phytochemistry and Pharmacology

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Abstract: Alzheimer's disease is a state of chronic neuronal degeneration that progressively affects neuronal cells, resulting in an impairment in cognitive function and memory over the years. Being the most common type of dementia worldwide, it is responsible for no less than two-thirds of incidences in adults who are 65 years and older. Alzheimer's disease is clinically marked by cholinergic dysfunction, buildup of aberrant neuritic plaques, and fibrillary tangles in the brain. To date, there is no concrete medication or therapeutic approach for reversing Alzheimer's disease that may fully restore the degenerated brain functioning. Spices are a very important component of Indian cuisine and have been used as food seasonings or home remedies for mild ailments for many generations. Interestingly, emerging research findings suggests that spices may reduce the likelihood of developing neurological disorders, including Alzheimer's disease. The growing acceptance of spices is primarily due to their perceived efficacy, affordability, and safety. Many Indian spices, such as turmeric, cinnamon, and members of the pepper family, have been reported to have the ability to reduce inflammatory cascades, function as antioxidants, and inhibit acetylcholinesterase and amyloid β aggregation. This review offers a summary of the phytochemistry, biological and cellular activities, and potential therapeutic usage of various spices in the therapeutic management of Alzheimer's Disease.

Keywords: Alzheimer's disease, Amyloid β , Neurodegeneration, Phytochemistry, Spices.

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INTRODUCTION

Globally, millions of people battle with Alzheimer's disease (AD), which is among the most common neurological illnesses, whose prevalence continues to worsen with age. It is marked by memory loss linked particularly to cholinergic neuron degeneration [1]. Late-onset AD (LOAD) is the term for AD that usually appears after the age of 65. Nearly five percent of sufferers of AD have early-onset AD (EOAD), which is far less prevalent and manifests before the age of 65 [2]. In 2022, AD was the seventh most prevalent cause of fatalities in the United States, whilst COVID-19 was the fourth, based on statistics compiled by the Centers for Disease Control and Prevention (CDC). AD was also reported to be the sixth most common cause of life loss after stroke, prior to the COVID-19 outbreak [3]. Although AD itself does not directly cause mortality, it greatly heightens an individual's likelihood of encountering other serious complications that could eventually lead to death.

Usually, AD presents as an ongoing degradation of intellectual ability and episodic memory, followed by additional symptoms including linguistic and visuospatial impairment. Such alterations are commonly coupled with behavioral disorders such as apathy, aggression, and depression [4].

A plethora of factors, including genetic background, aging, and environment, contribute to its complex etiology. It was also found that several key lifestyle choices, like adequate sleep, minimal alcohol consumption, abstention from smoking, physical exercise, and a balanced diet, reduced the risk of Alzheimer's disease progression. The amyloid- β aggregation, inflammation, cholinergic neuronal loss, oxidative stress, glutamate excitotoxicity, metal ions, and microbiota-gut-brain axis are some of the concepts that currently make up our understanding of this worldwide threat. However, a supplementary study is needed to comprehend the main causes of AD and understand how these factors interact with each other to create a milieu favorable for the disease's onset. The majority of currently available medications are symptom-oriented, and none of them are able to provide permanent relief. Most agonizingly, they also have unfavorable side effects. Moreover, their long-term effectiveness is not validated either. As a result, finding safer and more efficient AD medications continues to be a major challenge for the global scientific community [5].

With a history stretching over centuries and being a primary therapeutic component of herbal medicine, Ayurveda is regarded as one of the earliest forms of medicine in India. Spices are a popular choice for medical use because of their low-calorie content, richness of antioxidants, and ease of affordability [6]. Familiar Indian spices that have demonstrated promise in addressing a variety of

age-associated neurological conditions include black pepper, cumin, fennel, fenugreek, cloves, cardamom, coriander, and others [7]. Herbs like turmeric, brahmi, ashwagandha, dhania, etc., are showing increasing evidence for their therapeutic potential for cognitive impairment [8]. According to studies, certain spices, like saffron, rosemary, cinnamon, and ginger, are anti-inflammatory in nature and play an antioxidant role that helps prevent acetylcholinesterase and amyloid from aggregating [9].

This review deals with the etiology and pathophysiology of AD with special emphasis on the potentiality of spices to combat this worldwide cognitive pandemic.

ALZHEIMER'S DISEASE: ETIOLOGY AND PATHOPHYSIOLOGY

Etiology of AD

The exact etiology of AD is not known. However, several factors have been demonstrated to affect the onset of AD in people. These factors include age, gender, head injury, sleep disorders, and history of previous neurological issues [10, 11]. In general, people older than 65 years of age are more prone to developing AD [12]. Studies have claimed that the existence of the apolipoprotein E4 gene allele affects the onset of late-onset AD [13]. Therefore, genetic factors are also critical to the early or late onset of AD. Mutations in presenilin-1 (PS1), presenilin-2 (PS2, subcomponent of gamma-secretase), and amyloid precursor protein can be responsible for the early onset of AD, which is a rare occurrence and mainly seen in people aged 63 to 65 [13]. Therefore, changes at the genetic level or the presence of specific alleles can be crucial for the onset of AD.

The transmembrane protein for amyloid precursor has a single membrane-spanning domain [14]. The amyloid precursor protein is expressed throughout the body. However, the degree of expression can be influenced by the physiological state of cells. The exact function of the protein is not fully understood. Nevertheless, accumulating evidence suggests that the amyloid precursor protein can be critical for maintaining neuronal structure and functions. This protein can act as the precursor of amyloid- β , which is neurotoxic in nature and can impact the survivability of neurons. Amyloid precursor proteins are transported along the axonal fiber to the presynaptic terminals and undergo deposition. Excessive deposition of amyloid- β contents leads to neuronal dysfunction and subsequent neurotoxicity. Usually, the accumulation of amyloid- β deposits at the synaptic terminus causes dementia and neurodegeneration, leading to the onset of AD [15].

Interestingly, in addition to genetic factors, various health issues are also responsible for the onset of AD in elderly people. Health ailments, including

Phytochemistry of Undervalued Spices: From Flavor to Therapeutic Food

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Abstract: In the culinary sector, herbs and spices are frequently used to provide flavor and aroma. Herbal spices are recognized for their nutritional, antioxidant, antibacterial, and therapeutic activities, in addition to their ability to enhance flavor. Certain herbs are also utilized as spices in numerous food recipes because of their attractive leaves. The undervalued spice crops are rich in benefits. Because of their easier growth and hardening in the wild, they can yield a harvest even under unfavorable soil and climate conditions. A large number of them have richer supplies of minerals, vitamins, and other nutrients. Undervalued spices have nutritional importance as well as medical significance; in Ayurvedic medicine, they are valued for their medicinal qualities. Hence, the present book chapter deals with phytochemistry and the utilization of underutilized spices as therapeutic food.

Keywords: Ayurveda, Bioactives, Flavor, Phytochemicals, Therapeutics, Undervalued spices.

INTRODUCTION

The prehistoric men's greatest invention, fire, is credited with transforming raw animal flesh and plant-based diets into delicious cooked foods. Spices are credited with giving the same flavor, scent, color, and pungency. When the primitive men prepared the meat and purposefully added spices, first for seasoning and then for flavor and scent, the usage of spices proliferated. Along with prepared food, the liquids were gradually flavored with aromatic spices, yet their healing properties were still unknown and concealed. However, gradually, people came to understand that spices improve the quality and therapeutic benefits of food in addition to adding flavor and taste [1]. Recently, there has been a notable increase in the use of spices and functional or therapeutic foods in everyday diets,

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primarily to reduce the risk of cancer and chronic diseases. In particular, there may be health benefits to some spices. They are classified as agents that reduce inflammation [2]. Numerous plant spices are used in food products as essential oils or ground dry powder. They are considered antibacterial agents and greatly reduce the incidence of different ailments in the human body. The industrial sector is very interested in the biological and pharmacological properties of spices, as they may be used as ingredients to make functional foods or nutraceuticals [3].

Crops are often defined as plants that humans can utilize and cultivate. However, certain crop species remain underutilized and neglected. As a result, they are assigned many connotations since they are not used to their full potential. Furthermore, wild relatives of important crops are also included. Not all traditional crops are native; some native crops are well-established, and crops that are neglected in one nation or region may be misused in another [4].

Food insecurity, disease, and malnutrition continue to be major contributors to the world's most pressing problems. While major crops help alleviate food scarcity and hunger, minor crops, such as spices, play an equally important role in providing bioactive compounds, phytopharmaceuticals, and nutraceuticals for disease prevention, healthy physical and mental development, and the prevention of acute deficiencies. Malnutrition and diseases go hand in hand; thus, in order to better manage chronic diseases like cancer, cardiovascular disease, diabetes, obesity, cognitive problems, and so on, alternative dietary methods, together with health and nutrition awareness programs, must be initiated. Numerous underdeveloped and allegedly neglected spice crops can serve as therapeutics for certain ailments (Fig. 1) [5].

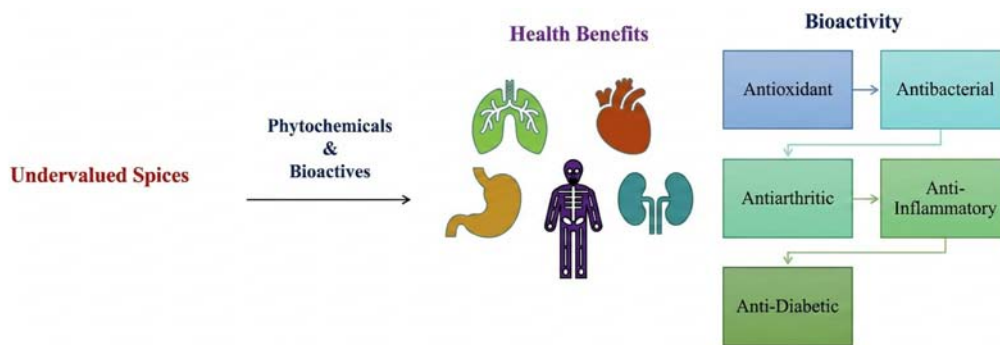


Fig. (1). Health benefits of undervalued spices.

The effects of underutilized spices can vary widely due to differences in their cultivation, harvesting, and processing methods, which in turn influence their structural, microscopic, macroscopic, and physicochemical properties [6]. The general mechanisms through which these spices operate can be outlined as follows:

1. **Reduction of Gastric Acid Secretion:** Underutilized spices may help lower the secretion of gastric acid, potentially impacting digestive efficiency.
2. **Inhibition of Gastrointestinal Transit:** These spices can slow down gastric emptying and intestinal motility, which may enhance nutrient absorption and overall digestive health.
3. **Alteration of Epithelial Cell Membrane Permeability:** They may modify the permeability of gastrointestinal epithelial cell membranes, influencing nutrient uptake and gut integrity.
4. **Cholagogue Activity and Thermogenic Effects:** Underutilized spices can promote bile production (cholagogue activity) and may exhibit bioenergetic and thermogenic properties, supporting metabolic functions.
5. **Inhibition of First-Pass Metabolism:** These spices may suppress first-pass metabolism and inhibit the activity of drug-metabolizing enzymes, thereby increasing the bioavailability of various compounds.

PHYTOCHEMISTRY AND PHARMACOLOGY OF UNDERVALUED SPICES

Alpinia Galanga

Alpinia galanga is also referred to as Kulanjan in Hindi and Greater galangal in English. It is used by the majority of South Indian doctors practicing traditional Ayurvedic and Siddha medicine to treat a variety of ailments, including diabetes mellitus. The rhizomes have a dark reddish-brown exterior, and cuttings of the inner rhizome have a dark core encircled by a broader, whiter layer on the outside, which becomes significantly darker as the rhizome dries during processing. Galangal rhizomes have a spicy or pungent flavor and a strong, fragrant scent. Due to its antibacterial, antifungal, anti-inflammatory, anti-hepatotoxic, antioxidant, immunodulator, anti-ulcerative, anti-tumor, and antiallergic properties, galangal rhizome is used as a therapeutic treatment for an array of ailments. It can be used to treat rheumatism, asthma, diabetes, heart disease, liver and kidney diseases, and back and stomach pain, as well as to boost appetite [7]. Prior studies were successful in isolating and identifying a number of active substances. 1,8-cineol, -fenchyl acetate, β -farnesene, β - α bisabolene, α -bergamotene, β -pinene, and 1'-acetoxychavicol acetate are the main active

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