Phyto-pharmacology of Herbal Medicinal Plants

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CHAPTER ONE

ADHATODA VASICA

Introduction

Plant products' therapeutic potential can be traced back more than 5,000 years, as there is proof that Indian, Egyptian, Chinese, Greek, and Roman civilizations used them to treat illnesses and rejuvenate bodily systems. Plants with medicinal potential are widely used in India by all socioeconomic groups as both traditional medicines in various indigenous medical systems like Siddha, Ayurveda, and Unani, as well as processed goods in the pharmaceutical sector. There are an estimated 4.5 million plant species in India, but only between 250,000 and 500,000 of these have had their phytochemical compositions examined for biological or pharmacological activity. The pharmaceutical industry may use plant extracts or bioactive components as a new formulation for the development of novel medications to treat a variety of ailments. Brahmi and Ashwagandha are examples of herbal remedies that can improve immunity, increase nutrients, and boost one's energy level. Medicinal and aromatic plants can contribute significantly to the improvement of rural people's subsistence livelihoods, particularly for women, in an environmentally friendly way while preserving the biodiversity of these natural resources. As much as 80% of the world's population currently relies on traditional medicine for their main healthcare requirements, according to the World Health Organization (WHO). The utilization of medicinal plants for the treatment of various diseases and the development of indigenous medicines both have significant economic advantages. Most people, especially in rural areas, are still obliged to use traditional medicines for their everyday diseases because of limited communication options, poverty, ignorance, and a lack of modern medical facilities. The importance of medicinal plants to both individual and societal health cannot be overstated. The chemical active compounds in plants that create specific physiological effects on the human body are what give them their therapeutic worth.

Adhatoda vasica (*A. vasica*) Nees. leaf (Vasaka), also known as Vasa in Ayurveda, is a crucial medication used for piles, leprosy, skin conditions, chronic fever, internal haemorrhage, cough, and asthma. It is reported to have anti-cancer, antibacterial, anti-microbial and antitussive properties. More than 20 Ayurvedic preparations, including *Vasarishta, Mahatiktaka ghrita, Triphala ghrita, Vasavaleha, Vasakasava, Mahatriphalaghrita, Panchatiktaghritaguggulu, and Panchatikta ghrita11, include Vasaka leaf* juice (Vasa swarasa). The traditional procedure for extracting vasaka juice is a complex one that requires heating a bolus of freshly crushed leaves. This technique cannot be used to extract juice on a large scale for commercial use. Therefore, updated procedures are being used to make swarasa in the commercial fabrication of formulations including Vasaka juice. Since the alkaloids were said to be the active principles, we prepared the leaf juice using a variety of methods, including the traditional method and steaming leaves to simulate the traditional method, and we evaluated these juice samples for the total alkaloid content and vasicine content.

Taxonomical Classification

Division: Spermatophyta
Subdivision: Angiospermae
Class: Dictyledonae
Sub class: Gamopetalae
Series: Bicarpellate
Order: Personales
Family: *Acanthaceae*

Synonyms

Hindi: Adosa, Arusha, Rus
English: Malabar Nut
Telugu: Addasaramu, Adamkabu, Adampaka
Bengali: Adulsa, Bakash, Vasok
Punjabi: Vamsa, Bhekkar
Marathi: Adulsa
Malyalam: Adolakam
Gujarati: Araduso, Aradusi, Adulso

Common Name: Malabar nut, adulsa, adhatoda, vasa, *vasaka*

Fig. 1: *Adhatoda vasica*

Cultivation

Found in the lowland of the drier to wetter tropics at elevations of up to 1,300 meters, this plant can handle temperatures between 12 and 32°C but thrives in environments with yearly daytime temperatures between 20 and 27°C. It can withstand temperatures as low as -1°C when dormant, but young growth might suffer serious damage at 2°C. Rainfall between 500 and 4,200 mm can be tolerated, but a mean annual rainfall between 700 and 1,700 mm is preferable. The plant also prefers a sunny location and can live with little shade. A pH between 6.5 and 7.5 is more suitable, but it is tolerant of 5.5 to 8. When introduced to new areas, this plant could turn into a weed since it is unpleasant to animals and has the capacity to colonize damaged areas and waste places.

Description

Acanthaceae family member *A. vasica* is a tiny, evergreen plant with broad, lanceolate (sharp, pointed like a lance) leaves that are 10 to 16 centimeters long and 5 centimeters wide. They taste harsh and turn greenish-brown when dried. They smell somewhat like strong tea. Soft-stem wood is excellent for making charcoal for explosives. Large, lovely white petals with purple striations on the lower lip make up the bloom. The fruit is a tiny capsule that contains four seeds.

Habitat

It grows in the majority of the Indian subcontinent and is a relatively common herbaceous plant there. Along with Panama, this herb is also found in Sri Lanka, Nepal, Pakistan, Indonesia, Malaysia, and China.

Traditional Uses

Malabar nut (*Adhatoda vasica*) has been used in Ayurvedic medicine to treat a wide range of illnesses, including bronchitis, leprosy, blood disorders, heart problems, thirst, asthma, fever, vomiting, memory loss, leucoderma, jaundice, tumours, oral problems, sore eyes, fever, and gonorrhoea. Bronchitis, tuberculosis, as well as other lung and bronchiole problems, can be effectively treated with *Adhatoda vasica*. Vasaka leaves can be brewed into a decoction to treat coughs and other cold-related symptoms. The expectorant will assist the release of phlegm deposits in the airway, and the calming action will help soothe throat irritation. Vasaka leaves can be used as a poultice to treat wounds since they are antibacterial and anti-inflammatory. When applied to joints, the poultice is beneficial for reducing the symptoms of rheumatoid arthritis. Vasaka has been used to treat peptic ulcers, piles, and bleeding gums as well as to reduce internal and external bleeding. Vasaka has blood-purifying, expectorant, and antispasmodic properties.

Chemical Composition

Vasaka alkaloids, of which vasicine is the most important, are the main components of the plant. Vasicine and vasicinone, two important alkaloids, are found in the leaves. Vasicine and vasicinone's pharmacological effects are well established. Recent studies on vasicine demonstrated bronchodilatory efficacy both in vitro and in vivo that was comparable to

theophylline. When both alkaloids were combined, there was a noticeable bronchodilatory effect. Additionally, vasicine has potent respiratory stimulant properties and thrombopoetic4 (platelet-increasing) action with vasicine has also been reported. The alkaloids have been found to have mild hypotensive and uterine stimulating effects. Vasaka leaves are abundant in vitamin C, beta-carotene, and essential oil. A study found that the essential oil (at a particular concentration) suppressed Mycobacterium tuberculosis.

Pharmacological Properties

The composition of the plant's main metabolites, particularly its alkaloid content, is associated with the plant's wide range of pharmacological effects. Alkaloid (vasicine) and its derivatives are thought to be responsible for the majority of A. vasica's pharmacological effects. The vasaka plant exhibits the following pharmacological effects that can be attributed to whole-plant extracts, portions used for extraction, or chemical components:

1. Antibacterial Activity

By using the disc diffusion method, it was discovered that the petroleum ether and ethanolic extracts from leaves have strong antibacterial activity against a variety of microorganisms, including Bacillus subtilis and Vibrio cholera. Regardless of the method—paper disc or dilution—the result is the same. Using leaf extracts from various solvents to combat bacteria like *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Bacillus subtilis*, *Enterococcus faecalis*, *Escherichia coli*, *Pseudomonas eugeniae*, *Klebsiella pneumoniae*, and *Candida albicans* may have potent antibacterial activity by preventing bacterial multiplication, according to a second study.

2. Anti-Asthmatic Activity

The leaf and root extracts are used to treat upper respiratory infections, coughs, and bronchitis. It releases phlegm, serving as an expectorant. Acetylcholine and histamine aerosol caused bronchial constriction in guinea pigs. By directly stabilising mast cells, obstructing the enzymes lipoxygenase and cyclooxygenase, or lowering platelet-activating factor, vasaka has an anti-asthmatic effect.

3. Antifungal Activity

According to Ramachandran and Sankaranarayanan, aspergillus ruber and trichophyton rubrum, two human pathogenic fungi, are inhibited by the phytochemical components of the plant.

4. Cholagogue Activity

At a dose of 5 mg/kg intravenous, the plant *A. vasica* exerts a significant effect on the liver and increases bilirubin output (by more than 40%) in animal models.

5. Anticholinesterase Activity

Vasicinone, an alkaloid derived from the roots of *A. vasica*, causes depression in the isolated frog heart in guinea pig models, as well as hypotension in a cat model and intestinal contractions.

6. Anti-Allergic Activity

The plant's active ingredients, vascinol and vasicine, have anti-allergic properties because they prevent ovalbumin-induced allergic reactions in mice, rats, and guinea pig models. *Adhatoda vasica*-containing patents are used to treat allergies (e.g. US 6746694).

7. Antimutagenic Activity

A group reported the anti-mutagenic effect of the herb vasaka against the renal oxidative stress and genotoxicity caused by cadmium chloride in the rat model. Pretreatment of the plant extract results in prophylaxis and a marked decrease in the level of oxidative biomarkers. According to a different study, the flavonoids and phenolic acids found in vasaka fractions may have anti-mutagenic properties. Hexane, chloroform, and water are the fractions with the most potential for control. The findings of this study support its potential future function as a chemopreventive agent.

8. Wound-Healing Activity

The therapy of wounds in the rat model has shown the value of the methanolic extract of *A. vasica*. Another study that generated a wound next to the vertebral columns of calves and then treated them with an alcoholic

and chloroform extract of *A. vasica* provided support for this investigation. The findings of this study indicate that alcoholic extract significantly speeds up wound-healing compared to other extracts. A different research team is examining the effectiveness of various vasaka leaf extracts against mouse models with excision-induced wounds. It was a striking outcome that the ointment (1% concentration) made with methanolic extract exhibits strong wound-healing properties.

9. Anthelmintic Activity

A. vasica was used by Shaibani et al. as an anthelmintic action against sheep gastrointestinal nematodes in vitro. The aqueous and ethanolic extracts of the plant were evaluated using tests for egg hatching and larval development. One extract, ethanolic, fared better than the other. At 800mg/kg, the plant extract exerts anthelmintic or anticestodal effects. The extract shows a significant reduction in recovery rate for the juvenile worms. *A. vesica* anthelmintic ability was contrasted in vitro and in vivo with that of the common drug levamisole. Aqueous and methanolic extracts both exhibit significant inhibitory activity in vitro, but the root powder has the most beneficial effects. Anthelmintic activity against nematodes is seen in both models.

10. Anti-Ulcer Activity

The pylorus ligation, ethanol, and aspirin-induced stomach ulcer are effectively treated by an ethanol extract of *A. vasica* leaves. However, the ethanol-induced stomach ulcer model in rats produced the best results. Another study on the syrup made from the plant extract reveals that it has strong anti-ulcerogenic properties and can also be used to treat dyspepsia.

11. Anti-Tuberculosis Activity

Due to Mycobacterium tuberculosis's multidrug resistance, antitubercular drugs have limitations. Aqueous vasaka leaf extract was tested in vitro for its anti-tubercular activity against isolates that were multidrug resistant. Several herbal treatments are used in Ayurveda to treat tubercular bacteria, one of which is derived from vasaka (gulkand) flowers. This effectively inhibits Mycoplasma tuberculosis growth in vitro when essential oil (2–20 g/ml) is used. It was given to Garhwal (Uttrakhand, India) as a coupon (MB105). Vasaka has significant anti-tuberculosis efficacy when used in

the disc diffusion method. In 1955, Barry et al. observed that *A. vasica* significantly inhibited the growth of Mycobacterium tuberculosis.

12. Anti-cancer Activity

The vasaka plant's antioxidant properties are used by the people of Chhattisgarh (India) to prevent cancer. The same effect may also be seen in animal models, which exhibit a marked reduction in hyperproliferative responses and carcinogenic activity in response to ferric nitrilotriacetate-induced renal oxidative stress and renal carcinogenesis. From an ethanolic extract of A. vasica, the alkaloid vassicine was extracted, and its acetylation produced vassicine acetate. The A549 lung cancer cell line has demonstrated that this substance is cytotoxic.

13. Global Perspectives and Future Approaches

Given the information above, it is evident that *A. vasica* is a plant that is frequently used to cure a number of disorders that are well-documented and listed in traditional and pharmaceutical usage. The table for biological use lists the various plant sections and their chemical components. As a result, it can be applied as a treatment plan and also to create a brand-new medication delivery system. Sufficient information must also be gathered on the chemical components and their structure-activity relationships, in order to investigate its subsequent actions, before it may be used in a variety of contexts. The information currently available will serve as a solid foundation for the creation of a new natural product with fewer negative effects than synthetic or chemical compounds. Additionally, it encourages research in agricultural business, which primarily focuses on herbal goods. A better resolution will be possible in the future thanks to the several bioactive chemicals that have been identified from *A. vasic.*

CHAPTER TWO

CARICA PAPAYA

Introduction

The literature study reveals that there is a dearth of thorough scientific knowledge regarding *Carica papaya* (*C. papaya*). The information acquired could serve as a foundation for future research on the anatomy and physiology of the plant, the creation of formulations, the writing of monographs, and the treatment of numerous ailments.

The *papaya* tree has flexible stems and resembles a palm. Originally from the tropics of the Americas, *carica papaya* (*C. papaya*) is currently grown in tropical, semi-tropical, and warm regions all over the world. The huge, juicy, melon-like, edible fruit of this tree, which bears black seeds in the center and often has an amber to golden hue, is also known as a *papaya*. Papaya is a year-round fruit that is a nutritional powerhouse; it contains a lot of fibre, minerals (magnesium and potassium), the B vitamin pantothenic acid, folate, and three potent antioxidants (vitamins C, A, and E).

Classification

Kingdom: Plantae
Clade: Tracheophytes
Clade: Angiosperms
Clade: Eudicots
Clade: Rosids
Order: Brassicales

Figure 2 *Carica papaya*

Family: *Caricaceae*
Genus: *Carica*
Species: *C. papaya*

Vernacular Names

Hindi: Papita
English: Papaya
Eclectics: Papaw
Brazil: Mamao
Carribean: Ababai
Cuba: Fruta da bomba
Synonyms: *Carica papaya*, melon tree, papaia, papaya tree, pawpaw.

Common Name: Papaya, Papita
Habitat: lowland tropical parts of Central and South America

Table 2.1 Plant Description

S.no.	Parameter	Flower Observation	Leave Observation	Fruit Observation	Seed Observation
1.	Shape and Structure	Round, pear-shaped or oval	Deeply lobed and often folded	Oval to somewhat round, pyriform, or elongated club-shape	Round seeds
2.	Odour	Fragrant	Bitterness	Musky, sweaty-sock-like stench overpowering	Sweet, fresh, fruity aroma
3.	Colour	Cream-white to yellow-orange petals	Green, yellow, and brown	Red, or orange flesh, and the other has yellow flesh	Black
4.	Touch	Smooth	Rough	Smooth	Smooth
5.	Size	2.5 to 5.1 cm	50 to 70 cm	15 to 45 cm	20 to 50 cm
6.	Taste	Bitter taste	Bitter taste	Sweet	Bitter

Table 2.2 Chemical Constituents

Chemical Constituent	Result
Carpaine	++++
Methyl gallate	+
Loliolide	+
Rutin	++
Clitorin	+
Kaempferol-3-O-neohesperidoside	+
Isoquercetin	+
Nicotiflorin	+
Isoharmnetin-3-O- β-D-glucopyranoside	+

Traditional Uses

Proteolytic enzymes with antiviral, antifungal, and antibacterial activities include papain and chymopapain. Papaya has been used as an emmebicide and an abortifacient. It can be used to treat digestive dyspepsia, fever, hypertension, arthritis, corns and boils, diarrhoea, and dysentery. It can also be used to treat asthma.

1. Antioxidant Activity

In mice given a dose of 100 mg/kg orally, the effects of the methanolic extract of unripe fruits of C. papaya on the activities of several antioxidant enzymes, including glutathione peroxidase (GPx), glutathione transferase

(GST), glutathione reductase, catalase, and glucose-6-phosphate dehydrogenase, were assessed in vivo. The ethyl acetate fraction significantly increases the activities of glutathione reductase, GST, GPx, and glucose-6-phosphate dehydrogenase. Following injection of the ethyl acetate fraction, a significant drop in GPx was seen in the kidney. The antioxidant potential of quercetin and -sitosterol was hypothesized to be related.

2. Anti-Hypertensive Activity

For the anti-hypertensive action, ripe C. papaya fruit was extracted ethanolically. The normotensive, renal, and DOCA-salt hypertensive animals' basal mean arterial blood pressures (MAP) were (93.84.5), (175.25.1), and (181.36.2) mmHg, respectively. In comparison to control, the doses of hydralazine (200 L/100 g, i.v.) and the ethanolic extract of unripe C. papaya fruit (20 mg/kg, i.v.) both significantly decreased the blood pressure (MAP) in the normotensive, renal, and DOCA-salt hypertensive animal groups. However, in the hypertensive group, the extract caused around 28% higher MAP depression than hydralazine. According to the study, unripe C. papaya fruit demonstrated significant anti-hypertensive activity potential.

3. Wound-Healing Activity

In streptozotocin-induced diabetic rats, the aqueous extract of C. papaya fruit [100 mg/(kg.d) for 10 d] has been shown to have wound-healing properties utilising excision and dead space wound models. In comparison to the controls' 59% contraction to the wound, the aqueous extract demonstrates a 77% reduction in the wound area. The conclusion was that *C. papaya's* aqueous extract has significant wound-healing potential.

4. Hepatoprotective Activity

The dried fruit of the papaya plant was extracted with water and alcohol to test for hepatoprotective effects in rats against CCl4-induced liver damage. By reducing biochemical indicators such SGPT, SGOT, serum bilirubin, and akaline phosphatase, the aqueous (250 mg/kg, p.o) and ethanol (250 mg/kg, p.o) extracts of *C. papaya* demonstrated considerable hepatoprotection.

5. Anthelmintic

With few adverse effects, the dried *papaya* seeds administered as an elixir with honey have demonstrated a strong effect on human intestinal parasites. The main anthelmintic is found in seeds and is called benzylisothiocynate. In experimentally infected mice, *papaya* latex possesses anthelmintic activity against *Heligmosomoides polygyrus*.

6. Ameliorative Effect of Leaves of C. Papaya in Hepatotoxicity

In order to conduct the study, rats were given an aqueous extract of C. papaya leaves at a dose of 400 mg/kg before receiving either ethanol or an isoniazid and rifampicin combination. The effects on tissue antioxidant measure such TBARS, GSH, and SOD as well as blood indices of liver damage (ALT, AST, alkaline phosphatase, and total bilirubin) were assessed.

7. Anti-Sickling Activity

Under osmotic stress conditions, the methanolic extract of *C. papaya* at a concentration of 10 mg/mL in vitro decreased hemolysis and safeguarded erythrocyte membrane integrity.

8. Anti-Ulcer Activity

50 mg/kg and 100 mg/kg p.o. doses of aqueous seed extract of *C. papaya* were effective against alcohol-induced acute stomach injury and blood oxidative stress in rats. Rats given 100 mg/kg of the extract experienced a considerable decrease in stomach acidity.

9. Female Antifertility

According to Sharma and Mahanta, a composite root extract that includes *papaya* root extract as one of the ingredients causes morphological alterations in the endometrial surface epithelium in the uterus of albino rats. The typical epithelium's distinctive smooth, uniform pattern appears to have been altered in certain spots by haphazardly arranged cell clusters and the lack of microvilli, creating an unkempt appearance. While petroleum ether, alcoholic, and aqueous extracts of seeds have been proven to impede rabbit

ovulation, seeds' aqueous extract has been demonstrated to have abortifacient characteristics in female Sprague Dawley rats.

10. Immunomodulatory Activity

In the macrophage cell line RAW 264, fermented papaya preparation has immunomodulatory and antioxidant action. It is also a macrophage activator that increases nitric oxide generation and TNF-alpha release without the need for lipopolysaccharides. The number of bioactive flavonoids in the antioxidant cocktail, which was created by fermenting unpolished rice, papaya, and seaweeds with useful lactic acid bacteria, yeast, and photosynthetic bacteria, has been proven to reduce lipid peroxidation in vivo.

Additional Benefits of Papaya

The papaya fruit provides an abundant source of vitamins and minerals, including pro vitamin A. carotenoids, vitamin C, vitamin B, lycopine, and dietary fibre. Papaya fruit contains the phytoalexin danielone. By adding papaya enzymes to our diet and demonstrating strong antifungal action against the harmful fungus Colletotrichum gloeosporiodes, this chemical helped to enhance our digestive health. An increase in appetite, relief from nausea, treatment of acne, relief from menstrual discomfort, lowering of fever, usage as a sunscreen and smoothing agent, meat tenderizer, and prevention of dandruff are some other advantages of papaya.

CHAPTER THREE

CURCUMA CAESIA

Introduction

There are thought to be between 350,000 and almost half a million species of vascular plants, which account for 10% of all vascular plants and nearly half of all vascular plant species. Plants have been utilised as medicine for thousands of years and are still used today. Initially, the trial-and-error approach was employed to treat illnesses or even just to feel better, and in this way, valuable plants with positive properties were identified. Traditional medicine is a term that refers to the progressive refinement of the use of these plants through many generations. Traditional medicine is defined as "the body of knowledge, skills, and practices based on the theories, beliefs, and experiences indigenous to different cultures, whether explicable or not, used in the maintenance of health as well as in the prevention, diagnosis, improvement, or treatment of physical and mental illnesses," according to the official definition. All civilizations have, in fact, created this type of medicine based on the plants native to their respective environments. Some authors have even asserted that the history of pharmacy and medicine can be traced back to this communicated information. Even now, thousands of higher plants are grown throughout the world to produce useful ingredients for medicine and pharmacy. Plants' healing abilities led to the development of pharmaceutical medications made from certain plants that have these advantages. Many plants' therapeutic capabilities, impact on the human body, and manner of use were known up to the 18th century, but the active ingredient was unknown.

Zingiberaceae plants are distinguished by their tuberous or non-tuberous rhizomes, which have potent aromatic and therapeutic qualities, including antioxidant and antibacterial characteristics and the ability to treat type 2 diabetes. The Zingiberaceae family, which includes the *genus Curcuma*, is said to have its origins in the Indo-Malayan region and is extensively distributed throughout the tropics of Asia, Africa, and Australia. About 40 of the 100 or more species in the *Curcuma genus* have been documented to

be of Indian origin. In India, black turmeric *Curcuma caesia (C. caesia)*, a perennial herb of the *Zingiberaceae* family, is also referred to as Kala Haldi or black turmeric.

The rhizome's flesh is bluish-black in colour and has a bitter, spicy flavour and odour. In north-eastern India, where *C. caseia* is a common plant, the tribal people consume the rhizomes as an appetiser, anthelminthic, and antipyretic. Black turmeric's essential oil was said to be antibacterial and effective against a variety of infections.

Taxonomy Classification

Kingdom: Plantae
Clade: Tracheophytes
Clade: Angiosperms
Clade: Monocots
Clade: Commelinids
Order: Zingiberales
Family: Zingiberaceae
Genus: *Curcuma*
Species: *C. caesia*

Vernacular Names

Hind: Kali Haldi
Manipuri: YaingangAmuba or Yaimu
Marathi: Kala-haldi
Telugu: NallaPasupu
Bengali: Kala haldi
Mizo: Aihang, Ailaihan
Assamese: kalahaladhi
Malayalam: Kari manjal
Sanskrit: RajaniNishaa, Nishi, Ratri.

Common Name: Black turmeric or black zedoary
Habitat: Rich humid and clayey soils

Fig. 4: *Curcuma caesia*

Agriculture

Black turmeric, commonly known as *C. caesia*, is a powerful perennial herb. This plant's stunning blue-green rhizomes have a flavour that is potent but faintly reminiscent of turpentine. Black turmeric becomes dormant for a portion of the year and changes to underground storage rhizomes to survive the winter. In the middle of spring, the plant produces bright pink and yellow blooms, and a few weeks later, four-foot-tall leaves with a crimson stripe along the midrib appear. In sandy loam, acidic soils with a pH range of 4.5 to 6.5, *C. caesia* thrives. Although it prefers some shade, it may thrive in open sun when grown under controlled conditions.

Traditional Uses

C. caesia Roxb.'s dried rhizomes and leaves are used to treat piles, leprosy, asthma, cancer, wounds, impotence, infertility, tooth pain, vomiting, and allergies. Fresh rhizome decoction is employed as an anti-diarrhoeic and as a stomach discomfort reliever. When a snake or scorpion bit you, *C. caesia* fresh rhizome paste was applied. When bitten by a bug or snake, the dried

powder from *Andrographis paniculata* Wall ex. Nees was combined with seed powder and applied.

Botanical Description

Morphology

The plant often stands upright and is between 0.5 and 1.0 metres tall. It is separated into an erect aerial shoot with leaves and a subterranean big ovoid tuberous rhizome that is frequently referred to as the rootstock.

Root

The major roots of the plant are hidden beneath the surface of the rhizome during rhizome propagation; however, adventitious roots that are yellow brown, long, fibrous, and tapering are visible everywhere.

Leaves

The leaves are typically found in groups of 10–20, and each one is glabrous, broad, oblong, and lanceolate, in a rich, vibrant purple. The centre section of the lamina is coloured. The petiole is ivory in colour and is surrounded by other petioles.

Flower

Flowers have a reddish border and are pale yellow in tone. Calyx: obtuse, 10-15 mm length, with 3 teeth. Collora: Semi-elliptic, long tubular, pale yellow lip.

Inflorescence

This is a thick spike between 15 and 20 cm long that appears well before the first leaf opens. The bracts of the coma are deep red and turn scarlet with age.

Rhizomes

The rhizome is tuberous, about 2–6 cm in diameter, and has a camphoraceous, fragrant smell. The shape and size frequently vary. It is sessile, laterally flattened, covered in adventitious roots, scars from roots,

and warts. In addition, it has longitudinal circular wrinkles on the surface that give the rhizome the appearance of nodal and inter-nodal zones. Rhizome surface (cork) is dark brown, bluish-black, or buff in colour. It displays circular groupings of scaly leaf remains that give the appearance of growth rings. More or less sympodial branching.

Distribution

North-east and central India have a sizable population of this plant. In the Papi Hills of Andhra Pradesh's East Godavari, West Godavari, and Khammam Districts, *C. caesia* is sporadic.

Bioactive Component of *C. caesia*

Maximum curcuminoids, oil content, flavonoids, phenolics, various crucial amino acids, protein, and high alkaloid content are all present in *C. caesia*, indicating a correlation between the presence of these bioactive secondary metabolites and the medicinal uses of *C. caesia* as fragrances, flavourings, and numerous significant useful pharmaceutical products.

Pharmacological Investigate and Molecular Analysis

Smooth Muscle Relaxant and Anti-asthmatic Activity

Arulmozhi et al. (2006) assessed *C. caesia's* anti-asthmatic properties. The relaxing properties of Curcuma caesia's hydroalcoholic extract (CC extract) were investigated in guinea pig trachea, as well as when various enzyme inhibitors and receptor antagonists were present. Additionally, in the depolarized rabbit aorta, the potential function of hydroalcoholic extract in calcium channel regulation was examined. The presence of an antagonist, such as propranolol, glibenclamide, 2′, 5′-dideoxyadenosine, a-chymotrypsin, L-NNA, or methylene blue, had no effect on the log concentration relaxing response curves of cumulative CC extract to carbachol (1 M)-induced pre-contraction. The CC extract concentration-dependently relaxed the carbachol (1 M)-induced pre-contractions.

Pritesh Paliwal et al. looked into the bronchodilator properties of *C. caesia* extracts. The extract's bronchodilator activity was investigated in guinea pigs with histamine aerosol-induced bronchospasm and pre-convulsion dyspnea. Treatment with 500 mg/kg of the methanolic CC extract demonstrated substantial protection against histamine-induced bronchospasm.

In this study, the H1 receptor antagonistic activity of the CC extract significantly prolonged the latent period of convulsions following exposure to histamine aerosol at the dose of 500 mg/kg and showed maximum protection of 34.84% at 4 hours as compared to chlorpheniramine maleate (standard) at 2 mg/kg, p.o. This supports the plant's anti-asthmatic properties.

Antioxidant Activity

Some medicinal *Zingiberales* members' rhizome extracts are frequently consumed in food as well as in traditional medicine. Antioxidant properties of *curcumin*, the chromium orange-yellow colouring substance found in turmeric rhizomes, have long been recognized. Using the sulphur free radical reactivity with *curcumin* as a reference indicator, Chirangini tested crude methanol extracts of the rhizomes of 11 species, including *C. caesia*, for their antioxidant capabilities. *C. caesia* provided a good level of radioprotection.

Analgesic Activity

The analgesic and antipyretic effects of several extracts derived from *C. caesia* and *C. amada* rhizomes were compared by Satija Saurabha et al. Rats with brewer's yeast-induced hyperthermia and a chemical model of acute pain were used to test the plant extracts' analgesic and antipyretic effects. When rats were given dosages of 250 and 500 mg/kg body weight, writhing and pyrexia were seen. Both plants had antipyretic and analgesic effects. Whereas *C. amada* responded more favourably than *C. caesia*.

Anti-Fungal Activity

C. caesia rhizomes were found to have antifungal action by Banerjee and collegues. It has long been recognised that the essential oil from the rhizomes of *C. caesia* Roxb possesses antifungal properties.

Anticonvulsant Activity, Muscle Relaxation and Locomotor Depressant

Indrajit Karmakar et al. tested the MECC in experimental animal models for several neuro pharmacological activities like analgesic, locomotor, anticonvulsant, and muscle relaxant effects. Writhing caused by acetic acid was significantly inhibited at both test concentrations as compared to the

control group in a dose-dependent manner. In the tail flick test, mice's reaction times were significantly lengthened by MECC at both doses. In a study on locomotor activity, it was discovered that MECC significantly and dose-dependently decreased mouse locomotor activity. When used as a pre-treatment for anticonvulsants, MECC demonstrated considerable and dose-dependent protection against PTZ-induced convulsions in mice by postponing the onset of the seizures and regaining control of the animals, resulting in survival.

Anxiolytic and CNS Depressant Activity

The MECC rhizome's potential for suppressing the central nervous system (CNS) was examined by Indrajit Karmakar et al. Hypnotic activity, the forced swim test, and the tail suspension test were all examined for MECC. Pentobarbital-induced sleep induction was significantly and dose-dependently reduced by MECC (50 and 100 mg/kg; i.p.) in terms of both the onset and length of sleep. MECC significantly reduced mice's immobility times in both the FST and the TST over the course of seven days at doses of 50 and 100 mg/kg intraperitoneally (i.p.), showing that it has an antidepressant-like effect.

Anthelmintic Activity

In a study by Gill Randeep et al., the anthelmintic activity of the two most well-known species of *Curcuma*, *C. amada* and *C. caesia*, was demonstrated in four selections from this study. At three different concentrations, the anthelmintic activity of petroleum ether, dichloromethane, ethanol, and an aqueous extract of the rhizomes of *C. amada* and *C. caesia* were examined. The paralysis time and time of earthworm death were measured for each extract at three concentrations (50 mg/ml, 100 mg/ml, and 150 mg/ml). All of the two plants' extracts showed dose-dependent efficacy. According to the results, *C. caesia* ethanol extract (150 mg/ml) was the most efficient at paralysing earthworms, while both Curcuma species' ethanol extracts (150 mg/ml) and dichloromethane extracts (150 mg/ml) were quite successful at killing them.

Antibacterial Activity

The antioxidant and antibacterial properties of oleoresins extracted from nine different *Curcuma* species were studied by Angel Gabriel Rajamma et al. Oleoresins were extracted from the rhizomes of nine starchy Curcuma

species (*Curcuma aeruginosa, C. amada, Curcuma aromatica,Curcuma brog, C. caesia, Curcumamalabarica, Curcuma rakthakanta, Curcuma sylvatica,* and *Curcuma zedoaria*) and tested for antioxidant and antibacterial activity. All of the species' oleoresins had high DPPH radical scavenging activity and ferric reducing power, which were positively correlated with the amount of phenol. Both g+ve (Staphylococcus aureus and Bacillus subtilis) and g-ve (Escherichia coli) bacteria were inhibited by the oleoresins. B. subtilis was found to have the highest level of sensitivity. According to the findings, the oleoresins from these species, the majority of which are underutilised, would be a wonderful addition to foods and medicines.

Anti-Ulcer Activity

An investigation of the anti-ulcer properties of an ethanolic extract of the *C. caesia* rhizome was conducted by Pranab KR Bordoloi et al. using experimental animals. In total, five albino rats were used in the investigation, divided into four groups of 150–200 g each. Group A: Control (5 ml/kg/day, orally, of 3% gum acacia). Group B: Experimental control (400 mg/kg of aspirin given orally once on the seventh day). Group C: Test (C. caesia extract 500 mg/kg/day orally for 7 days and Aspirin 400 mg/kg orally on the seventh day), and Group D: Standard (Ranitidine 150 mg/kg orally for 7 days and Aspirin 400 mg/kg orally on the seventh day). Rats that had been sacrificed had their stomachs removed. In contrast to group II, group III and IV exhibited a significant drop in the ulcer index, pepsin activity, free and total acidity, and volume of gastric juice, while gastric mucus secretion increased.

Analytical Analysis

High Performance Thin Layer Chromatography Studies

Reagents were purchased from Sigma-Aldrich in Steinheim, Germany, and standard *curcumin* was obtained from Merk in Germany. *C. caesia* air dried (45–55°C) powdered rhizome (1.0 g) was independently extracted with 3–10 ml methanol in triplicate. Prior to HPTLC examination, extracts were concentrated under vacuum, redissolved in methanol, filtered, and then made up to 100 ml with methanol.

Chromatographic Conditions

Merk HPTLC precoated silica gel 60 GF254 (20 ×20 cm) plates were used for chromatography. Using a Camag Linomat 5 automated TLC applicator with nitrogen flow, which provides a delivery speed of 150 nl/s from application syringe, methanolic solutions of the samples and the standard compound curcumin of known concentrations were applied to the layers as 6 mm-wide bands positioned 15 mm from the bottom and 15 mm from the side of the plate. Throughout the sample analysis, these circumstances remained constant.

GC–MS Analysis

On an Agilent 7890A gas chromatograph attached to a 5975C mass detector and Rxi-5Sil MS column (fused silica, 30 m 250 m 0.25 m), GC-MS analysis was carried out. The column was initially kept at 70°C, and after that, the temperature was raised by a gradient of 4°C/min up to 190°C, followed by 8°C/min up to 230°C, it was then held at 230°C for 2 min (for a total run time of 37 min). 150°C was kept as the inflow temperature. A flow rate of 1.0 mL/min of helium was used as the carrier gas. After being dissolved in n-hexane (5 mg/mL), the sample was injected with 1.0 mL of the resulting solution. The data was analysed and processed using GC/MSD Chem Station Software. By comparing the data from 70 eV mass spectrum analysis with the mass spectral library reference from the National Institute of Standards and Technologies (NIST), the identities of individual peaks were anticipated.

CHAPTER FOUR

MADHUCA LONGIFOLIA

Introduction

Since the time of Ayurveda, herbal remedies have been regarded as the cornerstone of traditional medicine due to their powerful pharmacological effects, which makes them a viable source for the creation of new drugs. In developing nations, traditional medicines are still used by more than 75% of the population. Scientific research has shown that chemicals originating from plants exhibit a wide range of effectiveness and safety with significantly fewer adverse effects than synthesised substances. Consequently, there is a need to expand the screening of plants with therapeutic value. The sapotaceae family includes *Madhuca longifolia* (*M. longifolia*), often known as the mahua or butter nut tree (Mahva, Mohva, Mohua, Erappe, Ippa, Iluppai, Madhukah, Irippa). These are common medium-sized deciduous evergreen trees found in Sri Lanka, Nepal, and India. Due to its diverse pharmacological qualities, *M. longifolia* is utilised in traditional and folklore medicine in many forms. As a result, it is also known as ayurvedic medicine's "universal panacea." Different portions of *M. longifolia* have demonstrated efficacy in the treatment of disorders such as epilepsy, diabetes, inflammation, bronchitis, ulcers, and other conditions. Utilised as a biofuel and an edible fat, *madhuca* oil is derived from the seed and possesses potent antibacterial and antioxidant effects. The blooms have been used as a cooling agent, astringent, demulcent, and a clinical trial has demonstrated their ability to increase sperm counts. They are well recognized for its decreasing sugar content. *M. longifolia* leaves contain antioxidant qualities and are used to treat Cushing's disease and bronchitis. Itching, edoema, snake venom, and diabetes have all been treated using the barks. *Madhuca*, a 17 m tall tree with a broad crown usually known as a *mahua* or butternut.