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A COMPREHENSIVE REVIEW ON THAI BASIL

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ABSTRACT

Thai basil(Ocimum basilicum L.) is an aromatic medicinal and culinary herb belonging to the family Lamiaceae and is widely valued for its distinctive aroma, flavor, and diverse pharmacological properties. This review provides a comprehensive overview of Thai basil, focusing on its botanical characteristics, traditional uses, phytochemical composition, nutritional importance and therapeutic potential. The plant contain several bioactive constituents, including essential oils, phenolic compounds, flavonoids, terpenoids, and other secondary metabolites, which contribute to its antioxidant, antimicrobial, anti-inflammatory, antidiabetic, cardioprotective, hepatoprotective, anti-cancer, activities. Particular attention is given to major constituents such as eugenol, linalool, methyl chavicol (estragole), and rosmarinic acid, which are associated with many types of its biological effects. The review also discusses extraction methods, factor affecting phytochemical composition, and reported pharmacological activities of different plant part. In addition, the potential applications of Thai basil in pharmaceutics, neutraceutical food and cosmetics formulations are highlighted. Available scientific evidence indicates the Thai basil represent a promising sources of natural bioactive compounds, however, further standardized studies, toxicity, evaluation, clinical investigations, and quality control approaches knowledge of Thai basil and identities opportunities for future research and development of safe effective herbal product.

KEYWORDS: Thai basil, Ocimum basilicum, Lamiaceace, phytochemical, essential oil, herbal medicine.

INRODUCTION

Medicinal and aromatic plants have been used for centuries as important sources of food, traditional remedies, and naturally occurring bioactive compounds. In recent years, increasing interest in herbal medicines has encouraged scientific investigation of plants used in traditional systems of medicine. Among these plants, basil species of the genus Ocimum are widely recognized because of their characteristic aroma, culinary importance, traditional uses, and diverse phytochemical composition. Thai basil is one of the important basil types associated with Southeast Asian culture and is particularly valued for its distinctive fragrance and flavor.[1]

Thai basil is generally associated with Ocimum basilicum L. of the family Lamiaceae. The plant is an aromatic herb characterized by green leaves, often purple-tinged stems, and terminal flower spikes. It is widely used in Thailand and other Southeast Asian countries as a culinary herb. The leaves are commonly incorporated into curries, soups, stir-fried foods, and other traditional preparations. Its slightly spicy, sweet, and anise-like aroma differentiates it from many other commonly cultivated basil types. In addition to its culinary value, Thai basil has attracted scientific attention because of its essential oils and other naturally occurring phytoconstituents.

Historically, basil plants have been cultivated and utilized in different regions of Asia and have spread through trade, cultivation, and cultural exchange. In Southeast Asia, different basil varieties became integrated into local food and traditional herbal practices. The broader Ocimum genus also has a long history of medicinal use. However, Thai basil should be distinguished from Tulsi (Ocimum tenuiflorum), which has a well-established role in Ayurveda. Tulsi has traditionally been used in Ayurvedic practices in preparations associated with respiratory health, digestion, fever, and general wellness. Although Thai basil is not identical to Ayurvedic Tulsi, the traditional importance of related Ocimum species provides useful historical context for investigating Thai basil.[2]

Phytochemical investigations have demonstrated that basil plants contain several groups of secondary metabolites, including essential oils, phenolic compounds, flavonoids, terpenoids, tannins, and other bioactive constituents. The chemical composition may vary according to

cultivar, geographical origin, environmental conditions, plant maturity, and extraction method. Important volatile constituents reported from basil varieties include compounds such as linalool, methyl chavicol (estragole), and eugenol, although their relative concentrations can differ among plant varieties.[3]

The presence of these phytoconstituents has stimulated research into the biological properties of Ocimum basilicum. Various studies have investigated basil extracts and essential oils for potential antioxidant, antimicrobial, anti-inflammatory, and other pharmacological activities. These properties have increased interest in the possible use of Thai basil in herbal formulations, pharmaceutical research, food applications, and natural-product development. Nevertheless, differences in plant varieties and extraction procedures emphasize the need for proper botanical authentication, phytochemical standardization, and systematic pharmacological evaluation.[4]

Vernacular name

Language	Name
English	Thai basil/Thai sweet basil
Thai	Horapha
Hindi	Babui Tulsi/ Van Tulsi
Sanskrit	Surasa
Bengali	Babui Tulsi
Tamil	Tiruneetra Pachilai
Telgu	Rama Tulsi



Plant Profile

Parameter	Description
Common name	Thai Basil
Family	Lamiaceae
Genes	Ocimum
Species	Ocimum Basilicum
Plant type	Aromatic Annul/Parennial herb
Origin	Southeast asia
Scientific Name	Ocimum Basilicum var. thyrsiflora
Stem	Erect, Branched, Usually green to purple
Leaves	Green, Opposite Aromatic and ovate

Taxonomical Classification

Kingdom- Plantae

Clade- Angiosperms

Order- Lamiales

Division- Magnoliophyta

Class- Magnoliopsida

Family- Lamiaceae

Genus- Ocimum

Species- Ocimum basilicum L.

Veriety- Thai Basil (Ocimum basilicum var. thyrsiflora)

Plant Description

Thai basil is an aromatic herb belonging to family Lamiaceae. It is an annual or Short-lived herbaceous plant that is widely cultivated in tropical and subtropical region for its characteristic fragrance and culinary as well as traditional medicinal applications. The plant generally developed an upright and branched growth habit and can reach approximately 30-60cm in height, depending on environmental and cultivation conditions.

The stem is erect, branched, and generally four-angled, which is characteristic feature of many member of the Lamiaceae family. Young stem many show a green to purplish coloration and possses a slightly hairy surface. The leaves are arranged oppositely on the stem are usually oval to lance-shaped, with a smooth or slightly toothed margin. Thai basil leaves are typically green, sometimes exhibiting a purplish tinge, and contain numerous essential -oil gland responsible for their distinctive sweet, spicy, and anise-like aroma.[5]

The inflorescence occurs mainly in elongated terminal spikes. The flowers are small and arranged in whorls along the flowering axis. They are generally pinkish-purple to violet in colour and are characteristic of the bilabiate floral structure found in the Lamiaceae family. The calyx is persistent, while the corolla is two-lipped and adapted for insect pollination. The plant produces small, dark-coloured seeds that develop after flowering.

Thai basil possesses a well-developed root system, consisting of a primary root with several lateral branches that anchor the plant and facilitate absorption of water and nutrients. The aerial parts, particularly the leaves and flowering tops, are rich in volatile constituents and other phytochemicals. The characteristic aroma of Thai basil is mainly associated with its essential-oil composition, which contributes to its traditional culinary and medicinal importance.[6]

Phytochemical Review

Thai basil (Ocimum basilicum var. thyrsiflora) contains a diverse range of biologically active compounds that contribute to its characteristic aroma, flavour, and reported pharmacological properties. The phytochemical composition can vary depending on the plant part, geographical origin, cultivation conditions, maturity of the plant, and extraction method. Both volatile and non-volatile constituents have been reported from Thai basil.

The essential oil is one of the most important phytochemical fractions of Thai basil. It contains aromatic compounds such as methyl chavicol (estragole), linalool, methyl eugenol, eugenol, 1,8-cineole, and other terpenoid constituents. Methyl chavicol and linalool are frequently associated with the characteristic sweet and anise-like aroma of Thai basil. The relative concentration of these constituents may differ considerably between different cultivars and growing conditions.[7]

Thai basil also contains several classes of phenolic and flavonoids. Reported phenolic constituents include rosmarinic acid, caffeic acid, ferulic acid, p-coumaric acid, and related phenolic derivatives. Flavonoids such as quercetin, kaempferol, apigenin, and luteolin derivatives have also been identified in Ocimum species. These compounds are of particular pharmaceutical interest because phenolic and flavonoid constituents are associated with antioxidant and other biological activities.

In addition, the plant contains tannins, saponins, glycosides, terpenoids, steroids, and other secondary metabolites. The presence and quantity of these compounds depend strongly on the plant material and extraction solvent. The leaves and flowering parts are particularly important sources of essential oils and phenolic constituents.[8]

Major Phytochemical Groups of Thai Basil

Phytochemical Group	Representative compound
Essential oil	Methyl chavicol (estragole), linalool, eugenol, methyl eugenol, 1,8-cineole
Phenolic compound	Rosmarinic acid, caffeic acid, ferulic acid, p-coumaric acid
Flavonoids	Quercetin, kaempferol, apigenin, luteolin derivatives
Terpenoids	Monoterpenes and sesquiterpenes
Tannins	Various condensed and hydrolysable phenolic constituents
Saponins	Triterpenoid and related saponin compounds
Glycosides	Various phenolic and flavonoid glycosides
Steroidal Compounds	Phytosterol-type constituents

- **Essential Oils**

Thai basil contains aromatic volatile oils.

Major compounds include methyl chavicol (estragole), linalool, eugenol, methyl eugenol, and 1,8-cineole.

These contribute mainly to its characteristic aroma and biological activity.

- **Phenolic Compounds**

These are plant compounds with antioxidant properties.

Important examples are rosmarinic acid, caffeic acid, ferulic acid, and p-coumaric acid.

They may help protect cells from oxidative damage.

- **Flavonoids**

Flavonoids are another important group of antioxidant phytochemicals.

Thai basil contains compounds such as quercetin, kaempferol, apigenin, and luteolin derivatives.

- **Terpenoids**

These compounds contribute to the flavour, aroma, and biological properties of basil.

They mainly include monoterpenes and sesquiterpenes.

- **Tannins**

Tannins are phenolic substances that can bind with proteins.

Thai basil contains different condensed and hydrolysable tannin-type compounds.

- **Saponins**

Saponins are naturally occurring compounds that can produce a foaming effect in water.

Thai basil contains mainly triterpenoid and related saponins.

- **Glycosides**

Glycosides consist of a sugar component linked with another chemical group.

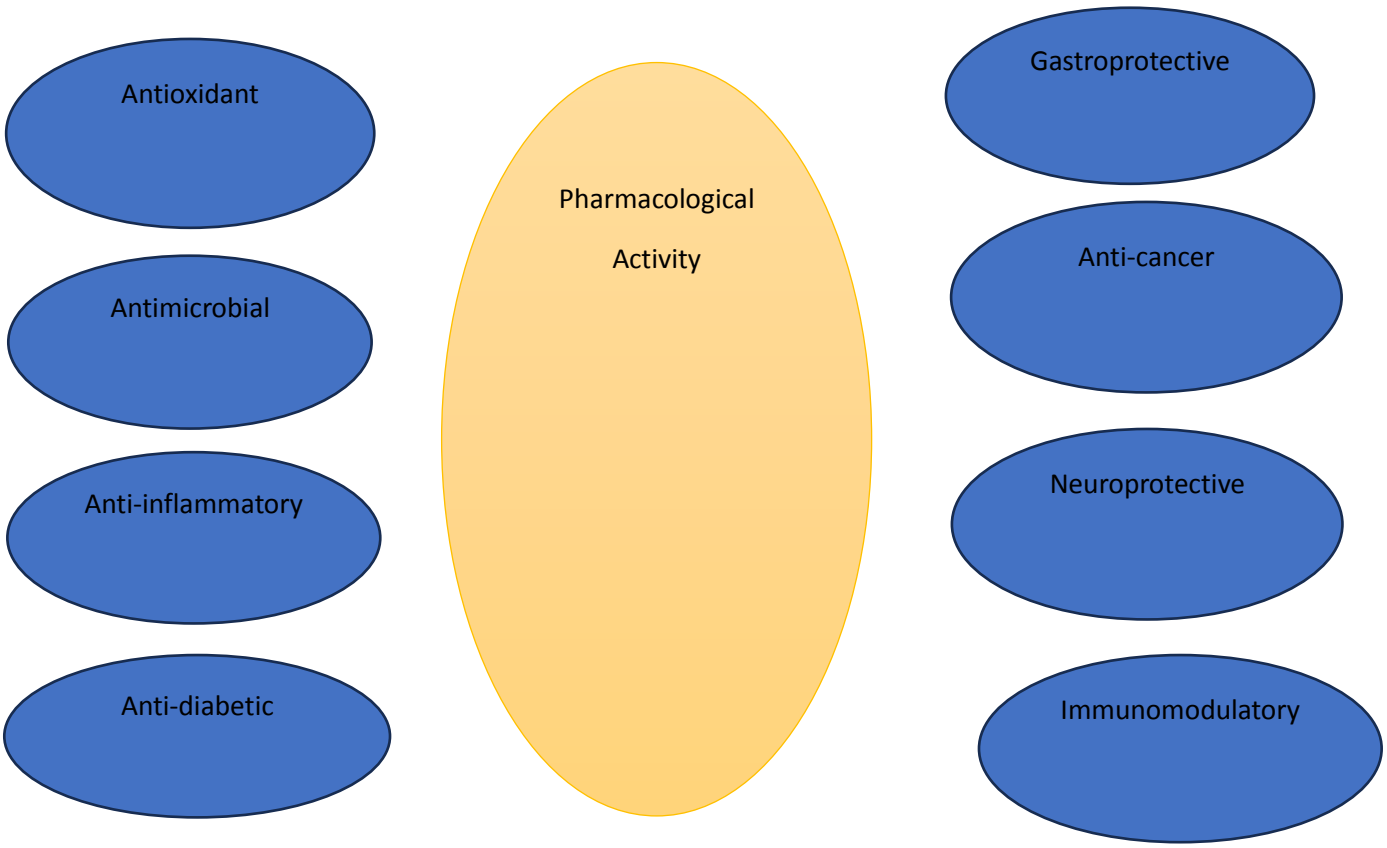
Thai basil contains various phenolic and flavonoid glycosides.

Steroidal Compounds

These include plant sterol-like substances known as phytosterols.

They are naturally occurring constituents associated with various biological functions.

Pharmacological Activity



Thai basil, Ocimum basilicum var. thyrsiflora, is a medicinal and aromatic plant that has attracted considerable interest because of its antioxidant properties. Oxidative stress occurs when the production of reactive oxygen species (ROS) exceeds the body's natural antioxidant

defense mechanisms. Excessive ROS can damage important cellular components, including lipids, proteins and nucleic acids, and may contribute to the development of several chronic disorders. The presence of naturally occurring antioxidant compounds in Thai basil may help counteract these harmful effects.[9]

The antioxidant activity of Thai basil is mainly associated with its phenolic compounds, flavonoids and other secondary metabolites. Compounds such as rosmarinic acid, caffeic acid, ferulic acid and flavonoid constituents can participate in free-radical neutralization and may contribute to the overall antioxidant capacity of the plant. These compounds can act through several mechanisms, including donation of hydrogen or electrons to unstable free radicals, inhibition of oxidative reactions and chelation of certain metal ions involved in free-radical generation.[10]

Different extracts of Thai basil have been evaluated using various in-vitro antioxidant assays. The DPPH (2,2-diphenyl-1-picrylhydrazyl) radical-scavenging assay is commonly used to determine the ability of plant extracts to neutralize free radicals. Thai basil extracts have shown concentration-dependent radical-scavengin g activity in such models. Other methods, including the ABTS radical-scavenging assay and ferric-reducing antioxidant power (FRAP) assay, are also useful for assessing the antioxidant potential of basil extracts. A higher content of phenolic and flavonoid compounds is generally associated with stronger antioxidant activity.[11]

The antioxidant capacity of Thai basil can vary considerably depending on plant variety, geographical origin, plant part, harvesting stage, extraction solvent and extraction conditions. Leaves are particularly important because they contain several bioactive phenolic constituents and volatile compounds. Polar solvents such as ethanol, methanol and hydroalcoholic mixtures can extract substantial amounts of phenolic and flavonoid compounds, although the composition and antioxidant response may differ according to the solvent used.[12]

The antioxidant properties of Thai basil are also relevant to its traditional and potential therapeutic applications. By reducing oxidative stress, its phytoconstituents may contribute indirectly to the protective effects reported for basil against inflammation and other oxidative-stress-associated conditions. However, antioxidant activity demonstrated by chemical assays does not necessarily establish therapeutic efficacy in humans. Therefore,

further cellular, animal and clinical investigations are required to establish the biological significance and mechanisms of these effects.

Mechanism of antioxidant action

The antioxidant activity of Thai basil can be summarized through the following mechanisms:

Free-radical scavenging: Phenolic compounds can donate hydrogen or electrons to unstable free radicals and convert them into relatively stable molecules.

Reduction of oxidative reactions: Basil polyphenols may reduce oxidation of cellular biomolecules.

Metal-ion chelation: Certain phytochemicals can bind metal ions that participate in oxidative reactions, thereby limiting free-radical formation.[13]

Protection of cellular components: Antioxidant constituents may help protect lipids, proteins and nucleic acids from oxidative damage.

Contribution of flavonoids and phenolics: These compounds collectively contribute to the antioxidant capacity of Thai basil extracts.[14]

Antimicrobial activity

Antimicrobial Activity of Thai Basil

Thai basil, Ocimum basilicum var. thyrsiflora, has received attention for its potential antimicrobial properties against a range of pathogenic microorganisms. The antimicrobial activity of the plant is associated with its diverse phytochemical composition, particularly essential oils, phenolic compounds, flavonoids, terpenoids and other secondary metabolites. These constituents may interfere with microbial growth through several mechanisms and therefore contribute to the traditional use of basil in various medicinal preparations.[15]

The essential oil obtained from Thai basil is considered an important contributor to its antimicrobial effect. Its volatile constituents, including linalool, methyl chavicol (estragole), eugenol and other terpenoid compounds, may interact with microbial cell membranes. Such interactions can alter membrane permeability, disturb cellular integrity and cause leakage of essential intracellular components. The resulting disruption can inhibit microbial growth and, at sufficiently high concentrations, may lead to microbial cell death.[16]

Different extracts and essential oils of basil have been investigated against both Gram-positive and Gram-negative bacteria. Bacterial species commonly examined in antimicrobial

studies include Staphylococcus aureus, Bacillus subtilis, Escherichia coli, Pseudomonas aeruginosa and other clinically relevant microorganisms. The degree of inhibition varies according to the bacterial species, concentration of extract, extraction solvent, plant part and experimental conditions.

Thai basil may also demonstrate activity against certain fungal microorganisms. Phenolic and volatile constituents can affect fungal membrane structure and interfere with processes required for normal fungal growth. This suggests that basil-derived preparations may have potential as natural antimicrobial agents; however, their activity should be confirmed using standardized microbiological methods.[17]

The antimicrobial action of Thai basil is thought to involve multiple mechanisms. Phenolic compounds may interact with microbial proteins and enzymes, while essential-oil constituents can disturb the lipid components of microbial membranes. Some phytochemicals may also interfere with microbial metabolism and cellular signaling. The combined action of several constituents may contribute to the overall antimicrobial response of the plant extract.[18]

Factors affecting antimicrobial activity

The antimicrobial effectiveness of Thai basil can be influenced by.

- Plant variety and genetic characteristics
- Plant part used, such as leaves, flowers or stems
- Extraction solvent and extraction method
- Concentration of the extract or essential oil
- Chemical composition of the essential oil
- Microbial species and strain
- Culture conditions and incubation period

Anti-inflammatory

Thai basil (Ocimum basilicum var. thyrsiflora) is an aromatic medicinal plant that has attracted considerable attention because of its diverse pharmacological properties. In traditional systems of medicine, basil has been used for conditions associated with inflammation, pain, and other inflammatory disorders. The anti-inflammatory potential of Thai basil is mainly attributed to its essential oil and various phytochemicals, particularly phenolic compounds, flavonoids, terpenoids, and phenolic acids. Important constituents

reported in basil include eugenol, rosmarinic acid, apigenin, luteolin, and other polyphenolic compounds, which may act individually or synergistically to regulate inflammatory processes.[19]

Inflammation is a natural protective response of the body against infection, tissue injury, and harmful stimuli. However, excessive or prolonged inflammation can contribute to several chronic disorders. During an inflammatory response, cells release mediators such as nitric oxide (NO), prostaglandins, tumor necrosis factor-alpha (TNF-α), interleukins, and other cytokines. Thai basil extracts have been investigated for their ability to modulate the production of some of these mediators. Experimental studies on Ocimum species indicate that basil-derived extracts and essential oils may suppress inflammatory signaling and decrease the release of inflammatory mediators, thereby reducing the intensity of the inflammatory response.

The phenolic and flavonoid constituents of Thai basil are particularly important because of their antioxidant and inflammation-modulating properties. Oxidative stress and inflammation are closely related processes; excessive formation of reactive oxygen species (ROS) can activate cellular pathways involved in inflammation. Basil polyphenols can help counteract oxidative stress by scavenging free radicals and supporting the body's antioxidant defense system. Through this antioxidant action, they may indirectly reduce oxidative damage and the subsequent activation of inflammatory pathways.[20]

Eugenol, an important component of basil essential oil, has been associated with anti-inflammatory effects in experimental studies. It may influence pathways responsible for the synthesis and release of inflammatory mediators. Similarly, rosmarinic acid and flavonoids such as apigenin and luteolin have been studied for their ability to regulate inflammatory signaling and oxidative stress. These compounds may interfere with pathways involved in the activation of inflammatory enzymes and cytokines. Such activities provide a possible scientific basis for the traditional use of basil in inflammatory conditions.[21]

The anti-inflammatory activity of Thai basil has been investigated using different in-vitro and experimental animal models, including models based on inhibition of inflammatory mediators, oxidative stress, and tissue responses. Although findings from Ocimum species provide promising evidence, the activity of Thai basil can vary according to plant variety, geographical origin, plant part, extraction solvent, extraction conditions, and concentration of

active constituents. Therefore, standardized extracts and well-defined experimental conditions are important when evaluating its pharmacological potential.

Also, The Thai basil represents a promising source of naturally occurring compounds with antioxidant and anti-inflammatory potential. Its ability to influence inflammatory mediators, together with its free-radical-scavenging properties, may explain some of its traditional medicinal applications. Nevertheless, further well-designed in-vitro, in-vivo, and clinical studies are needed to establish the precise mechanisms, effective doses, safety profile, and therapeutic significance of Thai basil as an anti-inflammatory agent.[22]

Anti-Diabetic Activity

Thai basil (Ocimum basilicum var. thyrsiflora) has attracted attention as a medicinal aromatic plant because of its diverse phytochemical composition and potential metabolic benefits. Experimental studies suggest that extracts of Thai basil and related Ocimum basilicum varieties may exhibit glucose-lowering and insulin-supporting effects. These activities are thought to be associated with phenolic compounds, flavonoids, essential oils and other bioactive constituents present in the plant.

One important mechanism may involve inhibition of carbohydrate-digesting enzymes, particularly α-amylase and α-glucosidase. These enzymes participate in the breakdown of dietary carbohydrates into absorbable sugars. Inhibition of their activity can slow glucose release and may help reduce the rapid elevation of blood glucose after meals. Phenolic and flavonoid constituents present in basil extracts are considered possible contributors to this enzyme-inhibitory activity.[23]

Thai basil may also have a role in improving glucose utilization and insulin sensitivity. Some experimental findings indicate that Ocimum extracts can influence pathways involved in glucose metabolism, potentially promoting better cellular uptake and utilization of glucose. The presence of antioxidant compounds may further support this effect because oxidative stress is closely associated with impaired insulin signalling and the progression of metabolic disorders.

Another potential mechanism is the antioxidant activity of Thai basil. Persistent hyperglycaemia can increase the formation of reactive oxygen species, resulting in oxidative damage to cellular components. Basil contains phenolic acids and flavonoids that can

neutralize free radicals and contribute to the maintenance of cellular antioxidant defence. By reducing oxidative stress, these compounds may indirectly support pancreatic β-cell function and normal glucose regulation.[24]

Animal and in-vitro investigations of Ocimum basilicum have reported beneficial effects on blood-glucose-related parameters, although the magnitude of activity can vary according to the plant variety, extraction solvent, plant part, dose and experimental model. Some studies have also suggested favourable effects on lipid metabolism, which may be relevant because abnormal glucose and lipid metabolism frequently occur together in diabetes.

Overall, the available experimental evidence indicates that Thai basil possesses promising anti-diabetic potential through multiple complementary mechanisms, including digestive-enzyme inhibition, antioxidant protection and possible improvement of glucose utilization and insulin responsiveness. However, much of the evidence remains preclinical, and further well-designed animal and clinical studies are required to establish its efficacy, appropriate dosage, safety and therapeutic relevance in diabetes management.[25]

Gastroprotective

Thai basil (Ocimum basilicum var. thyrsiflora) is an aromatic medicinal plant with considerable potential for protecting the gastrointestinal system. Its gastroprotective activity is mainly associated with the presence of flavonoids, phenolic compounds, terpenoids and essential-oil constituents. These bioactive compounds may help maintain the integrity of the gastric mucosa and protect it from various damaging factors.[26]

The antioxidant properties of Thai basil are particularly important in gastric protection. Excessive production of free radicals can cause oxidative damage to gastric cells and contribute to inflammation and ulcer development. Phenolic and flavonoid constituents of the plant may neutralize free radicals and reduce oxidative stress, thereby helping to preserve gastric tissue. Thai basil may also exhibit anti-inflammatory effects, which can reduce inflammatory damage and support recovery of the gastric mucosa.

In addition, basil extracts may enhance the natural protective mechanisms of the stomach, including maintenance of the mucus barrier and epithelial integrity. Experimental studies on Ocimum species have indicated a reduction in gastric lesions and improved protection against

experimentally induced gastric injury. The extent of this activity may depend on the plant variety, extraction method, dose and type of experimental model.[27]

Anti-cancer Activity

Thai basil (Ocimum basilicum var. thyrsiflora) is an aromatic medicinal plant that has received attention because of its various biological activities. It contains many naturally occurring compounds, including flavonoids, phenolic compounds, terpenoids and essential oils. These substances may contribute to the anti-cancer potential of the plant. Although research is still developing, experimental studies suggest that Thai basil and other Ocimum varieties may have protective effects against abnormal cell growth.

One important way in which Thai basil may act against cancer is by reducing the growth and multiplication of abnormal cells. Cancer cells normally multiply rapidly and can avoid the body's natural mechanisms for removing damaged cells. Certain compounds present in basil extracts may interfere with these processes and reduce the growth of cancer cells. Some studies have also suggested that basil constituents can promote apoptosis, which is a natural process through which damaged or unwanted cells are removed from the body.[28]

The antioxidant activity of Thai basil may also play an important role in its protective effect. Excessive free radicals can cause oxidative stress, which may damage cellular structures and DNA. Continuous oxidative damage can contribute to abnormal changes in cells and may increase the risk of cancer development. Phenolic and flavonoid compounds present in Thai basil can help neutralize free radicals and reduce oxidative stress. In this way, the plant may help protect cells from damage.

Thai basil also possesses anti-inflammatory properties, which may be relevant to cancer prevention. Long-term inflammation can damage tissues and create conditions that support the development and progression of abnormal cells. The phytochemicals present in Thai basil may help reduce inflammatory responses and thereby provide additional cellular protection. Its essential-oil components may also contribute to antioxidant and other protective activities.[29]

Laboratory studies of Ocimum extracts have reported growth-inhibitory or cytotoxic effects against some cancer cell lines. However, these effects can differ according to the plant variety, part used, extraction solvent, concentration and type of cancer cell tested. Therefore,

the results obtained from one extract or experimental model cannot be directly applied to all forms of cancer.

Overall, Thai basil shows promising anti-cancer potential through antioxidant, anti-inflammatory, cytotoxic and apoptosis-related effects. Its naturally occurring phytochemicals may help control abnormal cell growth and protect cells from oxidative and inflammatory damage. However, most of the available evidence comes from laboratory and preclinical research. More detailed animal studies and well-controlled human clinical trials are needed to determine its exact mechanism, effective dose, safety and possible role in cancer prevention or treatment.[30]

Neuroprotective

Thai basil (Ocimum basilicum var. thyrsiflora) is a traditional aromatic plant that may have beneficial effects on brain and nervous system health. It contains several naturally occurring compounds, including flavonoids, phenolic compounds, terpenoids and essential oils. These components are believed to contribute to the plant's protective effects on nerve cells.[31]

One of the major ways Thai basil may support brain health is through its antioxidant activity. Brain cells are particularly sensitive to oxidative stress because they require a high amount of oxygen for normal functioning. Excessive free radicals can damage neurons and affect their normal activity. Antioxidant compounds present in Thai basil may help control these free radicals and protect nerve cells from oxidative damage.[32]

Thai basil may also be useful because of its anti-inflammatory properties. Continuous inflammation in brain tissues can negatively affect neurons and may contribute to the development of certain neurological problems. The bioactive compounds in basil may help reduce excessive inflammatory responses and maintain a healthier environment for nerve cells.

Research on Ocimum species has also suggested possible benefits for memory, learning and cognitive function. The plant may help maintain normal neuronal communication and protect brain cells from harmful changes. Its antioxidant and anti-inflammatory effects may work together to support these activities.[33]

Overall, Thai basil appears to have promising neuroprotective potential. Its natural compounds may help protect neurons from oxidative stress and inflammation while

supporting normal brain function. However, most of the available evidence is based on laboratory and animal research. Further human studies are needed to clearly understand its effectiveness, safety and possible role in neurological health.

Immunomodulatory

Thai basil (Ocimum basilicum var. thyrsiflora) has attracted attention because of its possible role in supporting and regulating the immune system. The plant contains several biologically active compounds, including phenolic compounds, flavonoids and essential-oil constituents, which may contribute to its immunomodulatory properties. These natural compounds can influence different immune responses and may help the body maintain a balanced reaction to harmful stimuli.[34]

Research on basil suggests that its extracts may affect the activity of important immune cells, including macrophages and lymphocytes. They may also influence the release of cytokines and other signaling molecules involved in inflammation and immune regulation. This activity is important because an excessive immune response can lead to prolonged inflammation and tissue damage, whereas an inadequate response may reduce the body's ability to protect itself.

The immunomodulatory effects of Thai basil may also be related to its antioxidant and anti-inflammatory properties. Compounds such as rosmarinic acid, eugenol, apigenin and luteolin may help reduce oxidative stress and regulate inflammatory pathways. By controlling oxidative damage and excessive inflammatory responses, Thai basil may contribute to the maintenance of normal immune function.[35]

Overall, Thai basil appears to have promising immunomodulatory potential and may be useful as a natural source of bioactive compounds for maintaining immune balance. However, further experimental and clinical studies are needed to clearly understand its mechanism of action, effective dose and possible therapeutic applications.

Therapeutic uses and Traditional uses of Thai Basil

Thai basil (Ocimum basilicum var. thyrsiflora) is an aromatic herb that has been used for centuries as both a culinary ingredient and a traditional medicinal plant. It is particularly popular in Southeast Asian countries, where its leaves, stems and seeds are used in food preparations and traditional remedies. The plant is valued because it contains a variety of biologically active constituents, including essential oils, phenolic compounds and flavonoids.

These constituents are believed to be responsible for many of the biological properties associated with basil.[36]

Traditional Uses

Traditionally, Thai basil has been used as a household herbal remedy for a variety of common health complaints. The leaves are often consumed fresh or incorporated into food, while herbal preparations may be prepared from the leaves or other plant parts. In traditional practices, basil has mainly been associated with digestive, respiratory, antimicrobial and soothing properties.[37]

Digestive Uses

Thai basil has traditionally been used to support normal digestion. Preparations made from basil leaves have been consumed for complaints such as indigestion, abdominal discomfort, bloating and reduced appetite. The aromatic nature of the plant and its essential-oil constituents may contribute to its traditional use as a digestive aid. Traditionally, basil has also been used after meals as a refreshing herb.[38]

Respiratory Uses

Basil leaves have traditionally been used during common respiratory complaints such as cough, cold and throat discomfort. Herbal preparations containing basil may be consumed as warm infusions or incorporated into traditional remedies. Its aromatic components and possible anti-inflammatory and antimicrobial properties provide a scientific basis for investigating these traditional applications.[38]

Use in minor skin problems

In some traditional practices, crushed or prepared basil leaves have been used externally for minor skin complaints. The plant's antimicrobial and anti-inflammatory potential may partly explain this traditional practice. However, traditional topical use should not be considered a substitute for appropriate medical treatment of serious or persistent skin infections.[39]

Use for general health and well-being

Thai basil has also been traditionally regarded as a refreshing and supportive herb. Regular dietary consumption provides plant-derived phenolic compounds and other constituents. Because of its pleasant aroma and nutritional value, basil has been incorporated into everyday diets in addition to its medicinal use.

Traditional antimicrobial applications

Basil has traditionally been associated with protection against minor infections and microbial-related problems. The essential oil contains aromatic constituents that have demonstrated antimicrobial activity in experimental studies. This traditional use has encouraged scientific investigation into basil extracts and essential oils against different microorganisms.[40]

Therapeutic Uses and Pharmacological Potential

Modern research has investigated Thai basil and related Ocimum basilicum preparations for several pharmacological activities. These effects are mainly attributed to essential-oil components and polyphenolic compounds present in the plant.[41]

1. Antioxidant Activity

Thai basil contains phenolic compounds and flavonoids that can act as antioxidants. These compounds may help neutralize reactive oxygen species and reduce oxidative stress. Oxidative stress is associated with cellular damage and has been linked with several chronic disorders. Therefore, the antioxidant potential of Thai basil makes it an interesting plant for further investigation in nutraceutical and pharmaceutical research.[42]

2. Antimicrobial activity

Basil extracts and essential oils have shown antimicrobial potential against several microorganisms in laboratory studies. Components of the essential oil, particularly aromatic compounds, may interfere with microbial growth and cellular functions. This property has increased interest in basil as a possible natural source of antimicrobial agents. However, laboratory antimicrobial activity does not automatically establish effectiveness as a clinical treatment.[43]

3. Anti-inflammatory Activity

Thai basil may help regulate inflammatory processes through its bioactive constituents. Certain phenolic compounds and essential-oil components have been investigated for their ability to influence inflammatory mediators and signaling pathways. By potentially reducing excessive inflammatory responses, basil may have value in research related to inflammation-associated conditions.

4. Antidiabetic Potential

Basil has also been studied for its possible role in maintaining healthy blood glucose levels. Experimental research suggests that basil extracts may influence glucose metabolism and improve certain parameters associated with glucose regulation. Its antioxidant constituents may provide additional support by reducing oxidative stress associated with metabolic disturbances. More human studies are necessary before therapeutic claims can be made.[44]

5. Gastroprotective Activity

Traditional use of basil for digestive problems has led to interest in its gastroprotective potential. Experimental studies suggest that basil preparations may help protect gastric tissues from certain forms of damage. Antioxidant and anti-inflammatory mechanisms may contribute to this activity. Further research is required to determine whether these effects are clinically meaningful.[45]

6. Immunomodulatory Activity

Thai basil may influence immune responses through its phytochemical constituents. Experimental findings with basil preparations suggest possible effects on immune cells and inflammatory mediators. This activity may be related to the combined antioxidant and anti-inflammatory effects of the plant. The immunomodulatory potential of Thai basil remains an area requiring more detailed investigation.[46]

7. Neuroprotective Potential

The antioxidant and anti-inflammatory properties of basil have also generated interest in its possible neuroprotective effects. Oxidative stress and chronic inflammation can negatively affect nervous-system cells. Bioactive compounds present in basil may help counter these processes in experimental models. This suggests potential for future research into the protective effects of basil on neuronal health.[47]

8. Anticancer Potential

Various compounds found in Ocimum species have been investigated for their potential anticancer properties. Experimental studies indicate that certain basil constituents may influence cellular pathways associated with abnormal cell growth, oxidative stress and programmed cell death. These findings are promising at the experimental level, but they do not mean that Thai basil can be used as a cancer treatment. Clinical studies are required to establish its safety and effectiveness.[48]

9. Cardioprotective Potential

The antioxidant and anti-inflammatory properties of basil may also be relevant to cardiovascular health. Experimental studies have explored the effects of basil preparations on factors associated with cardiovascular function and oxidative stress. Its phytochemicals may potentially contribute to maintaining healthy physiological functions, although evidence from well-designed human clinical studies remains limited.[49]

10. Stress-relieving and calming effects

Basil has traditionally been associated with relaxation and general well-being. Some experimental studies on Ocimum species have examined possible effects on stress-related responses. The aromatic essential oil may also contribute to the plant's traditional use as a refreshing and calming herb. However, the exact mechanism and clinical relevance of these effects require further study.[50]

CONCLUSION

Thai basil (Ocimum basilicum var. thyrsiflora) is a useful aromatic herb that has an established place in traditional practices as well as in modern natural-product research. In addition to its culinary importance, the plant contains several chemically diverse constituents, particularly essential oils, phenolics and flavonoids. These compounds are associated with many of the biological effects reported for basil. The amount and composition of these constituents may change with plant part, growing conditions, geographical source and method of extraction, making quality control an important consideration.

The traditional use of Thai basil includes its incorporation into remedies for digestive discomfort, cough and cold-related complaints, minor skin problems and general health maintenance. Scientific investigations have examined these uses and have reported antioxidant, antimicrobial, anti-inflammatory, antidiabetic, gastroprotective, immunomodulatory and neuroprotective effects. The findings suggest that different groups of phytochemicals may act on several cellular processes, including oxidative damage, inflammatory signaling, microbial growth and glucose-related pathways. This wide range of reported effects helps explain the continued interest in Thai basil as a medicinal herb.

At the same time, the evidence available for individual activities varies considerably. Many investigations have been conducted under laboratory conditions or in experimental animals, and differences in extract concentration, preparation method and chemical composition can

produce different outcomes. Therefore, results obtained from one preparation cannot always be directly applied to another or interpreted as established clinical efficacy.

For the development of Thai basil-based products, greater attention should be given to authentication of raw materials, standardized extraction, phytochemical profiling and appropriate quality-control methods. Safety studies and clinical investigations are also necessary to determine suitable doses and confirm the relevance of experimental findings in humans.

Overall, Thai basil is a phytochemically rich herb with significant traditional importance and a broad range of scientifically investigated activities. Its documented properties provide a useful foundation for research in herbal medicines, functional foods and nutraceutical formulations. Carefulstandardization and stronger clinical evidence will be essential for converting these research findings into reliable, evidence-based applications.

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