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A complete overview of OcimumSpecies: King of herbs

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Abstract

Ocimum includes a wide variety of annual and perennial herb, and these plants demonstrate a wide range of morphological characteristics.The genetic adaptability and variation of these plants is highlighted by the wide morphological diversity that may be found within the genus *Ocimum*. These variations make basil more attractive visually and adaptable for use in food, medicine, and ornamentation. Some varieties may have robust and vigorous growth, while others may exhibit a more delicate nature. Plant height is another characteristic that shows considerable variation, with some species and cultivars growing as small, compact plants, while others can reach substantial heights. Branching patterns also contribute to the morphological diversity within the genus. Some basil plants have profuse branching, resulting in dense foliage, while others exhibit minimal branching, leading to a more open and airy growth habit. Leaves exhibit a wide range of variations in size, shape, texture, and color. Basil leaves can be small or large, elongated or rounded, smooth or textured, and range in color from vibrant green to purple, red, or variegated patterns. Flower color, another variable trait, can range from white to various shades of purple, pink, or blue. Flowering time, or the period when the plants produce flowers, can also differ among different basil varieties. In addition to their visual characteristics, basil varieties exhibit variations in flavour and aroma. The taste and fragrance profiles can range from sweet and mild to spicy, citrusy, or even licorice-like, offering a diverse sensory experience.

Keywords: morphological diversity, ornamentation, citrusy, sensory

Introduction

The *Ocimum*, or basil, is a genus that includes many widely used plants that are cherished for their aromatic, therapeutic, decorative, holy, and other aesthetic qualities. It is one of the largest genera in the Lamiaceae family and specifically a member of the Ocimoideae subfamily. It is a member of the Lamiaceae family and has about 65 different species. Geographically, the distribution of *Ocimum* indicates three major diversity hotspots: the tropical regions of America, Asia, and Africa[Enegide and Ofili Charles, 2021].

The name "*Ocimum*" originates from the Greek word "*Ozo"* which literally translates to "smell"[Hereman, 1868].It is frequently referred to as the "king of herbs" because of its extensive use in traditional medicine, the pharmaceutical industry, and perfumery[Simpson and Corner, 1986].This is due to the fact that it is one of the most fragrant of all plants. Basil's origins are thought to be in Iran and/or India. Worship of the holy plant Tulsi, which is central to the Hindu religion and practised all over India. The term "Tulsi" is originated from Sanskrit and translates to "incomparable one" or "matchless one" [Verma *et al*., 2011].Tulsi is grown all throughout the world and is classified into two types: Holy basil and Mediterranean basil. Holy basil, also known as Tulsi, is regarded with utmost veneration in India as a household plant. In Ayurveda and the Hindu faith, holy basil is associated with the goddess of wealth, health, and prosperity. It is further divided into four different species: *O. sanctum (Rama-tulsi), O. tenuiflorum (Krishna-tulsi), O. tenuiflorum (Amrita-tulsi), and O. gratissum (Vana-tulsi)*[Kruger, 1992].In the category of Mediterranean basil, there are various subgroups, including Sweet basil *(O. basilicum),* Thai basil *(O. thyrsiflora),* Lemon basil *(O. citriodorum),* Vietnamese basil *(O. cinnamon),* American basil *(O. americanum), and* African blue basil *(O. kilimandscharicum)*[Kaur et al., 2020].

Tusi leaves contain polyphenols and flavonoids, with rosmarinic acid being the most abundant compound. GC-MS analysis revealed that the compounds like methyl eugenol in Krishna (*O. tenuiflorum*), Bornanone in Camphor (*O. kilimandscharicum*), and caryophyllene in Vishnu variety of basil. The LC-MS/MS profiles of different Tulsi varieties showed variation among major compounds like mallic acid, citric acid, rosmarinic acid, and asiatic acid. These bioactive compounds have potential health benefits and are considered safe for potential nutraceutical applications of Tulsi[Priya and Peddha,2023].

Because of its medicinal and aromatic capabilities, species that are a part of the *Ocimum*genus have attained an enormous amount of popularity in recent years. This has made them significant in the pharmaceutical and food industries (Figure 1). The essential oil

that is extracted from *Ocimum*basil has a flavour that is distinct and admired for its quality. A wide variety of illnesses, including bronchitis, bronchial asthma, malaria, diarrhoea, dysentery, skin diseases, arthritis, chronic fever, and insect bites, have long been treated with various components of the*Ocimum* plant, including its leaves, stems, flowers, roots, seeds, and the entire plant. These components have been recommended by traditional medical systems for a long time. Researchers studied tulsi's phytochemical constituents, pharmacological properties, and traditional uses[Pandey, 2017;Cohen, 2014;Pradhan *et al*.,2022]. However, there is a lack of information on value addition of tulsi in current scenario and recent studies. This article helps to explore morphology and distribution of different species of *Ocimum.* This paper will be a good reference paper for those who are looking for versatile application of tulsi.

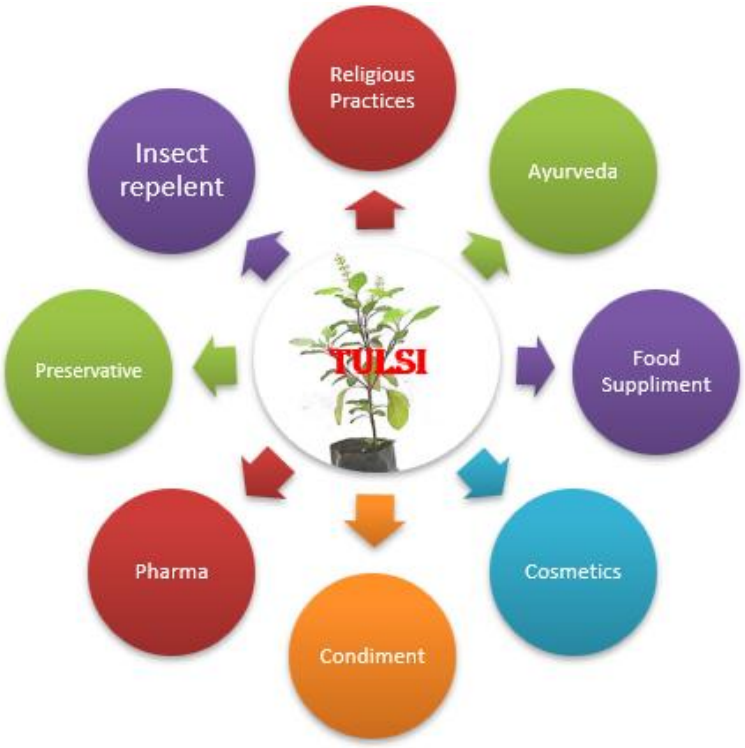

Fig.1 Application of Tulsi in different areas

Materials and methods:

To have a thorough understanding of the subject topic, a diligent and comprehensive review of the original work was conducted. To ensure a thorough investigation, we used recognized scientific databases such as Google Scholar, Science Direct, and PubMed. These databases provided with a large number of scholarly articles and research papers related to the inquiry subject. To narrow our search, we used the basil's name and its application in the context of health and disease as keywords. This strategic approach allowed us to concentrate exclusively

on literature and pharmacological activity, revealing light on the basil's potential medicinal characteristics and therapeutic benefits. The method entailed combing through a large number of published articles covering a wide spectrum of studies and findings, assuring that our investigation was founded on sound scientific evidence. We systematically collected data during this review process, identifying linkages between the selected papers that were the subject of our research.

Morphology

Ocimumcitriodorum

Lemon basil, scientifically known as *Ocimumcitriodorum*, can reach a height of 20-40 cm when fully grown. It produces delicate white flowers that bloom from the end of summer until the beginning of autumn. The leaves of lemon basil resemble those of regular basil, but they are noticeably narrower in comparison. Once the flowering period is over, the plant undergoes seed production. The seeds will eventually dry out while still attached to the plant [Tripathi *et al.*,2014].Lemon basil is the result of a natural hybridization process between sweet basil (*O. basilicum*) and African basil (*Ocimumamericanum*). This unique combination brings together the desirable traits of both parent species [Janarthanam andSumathi, 2012].This hybridization results in a basil variety with a refreshing lemon-like aroma and flavour, adding a unique twist to the culinary and medicinal uses of basil.

Ocimumkilimandscharicum

Camphor basil, often referred to as Kapur Tulsi, is an aromatic evergreen shrub that can live for multiple years and grow to a height of 15 to 30 cm.It is known as African Basil, Camphor Basil, Camphor-Scented Basil, Hoary Basil, Kilimanjaro Basil, Perennial Basil, or Fever Plant. In Sanskrit, the name KapuraTulasi means "fever plant." This plant is referred to as *Kampferbasilikum* in German, whereas in Hindi, it is referred to as KapurTulsi or KapuriTulsi. The widespread recognition and the cultural significance of camphor basil in a variety of regions of the world are reflected in the many different names for the plant. Its stems are brownish-green in colour. The camphor basil has leaves that are ovate and oblong in shape, and they have a brilliant green tint to them. They are pubescent on the surface of the leaves and are grouped in an opposite pattern along the stems. The leaves are thin at the base and deeply serrated, which contributes to the plant's visual appeal.The fruit of camphor basil is an indehiscent kind that consists of a single seed and is often seen clustered together.

Additionally, the hermaphrodite flowers of this plant are grouped together in clusters. The tap roots are deep, and the plant's wood is soft[Kabir *et al*., 2005].

Ocimumgratissimum

Ocimumgratissimum is an aromatic perennial herb that can reach a height of 1 to 3 meters. Its stem is erect, round-quadrangular in shape, and highly branched. The stem can be either glabrous (hairless) or pubescent (covered in fine hairs). At the base, the stem becomes woody and often has an epidermis that peels off in strips, adding to its unique appearance.The leaves of *Ocimumgratissimum* are always arranged opposite to each other along the stem. They have slender petioles that are 2 to 4.5 cm long and pubescent. The blade of the leaves varies in shape, ranging from elliptical to ovate. The leaves are membranaceous (thin and flexible) and sometimes have glandular punctate markings. The base of the leaves is cuneate (wedge-shaped) [Lexa *et al*., 2007].The flowers of *Ocimumgratissimum* are arranged in 6 to 10 flowered verticillasters. They are small in size and hermaphrodite, containing both male and female reproductive structures. The calyx of the flower is two-lipped and measures 2 to 3 mm in length. The fruits of the plant are pubescent, with the upper lip rounded and recurved. As the fruits mature, the upper lip reflexes, or bends backward.In Sanskrit, it is called Vriddhutulsi, while in Hindi, it is known as Ram tulsi. In Kannada, it is referred to as Nimmatulasi. In the southern part of Nigeria,the plant is called "effinrin-nla." The Igbos refer to it as "Ahuji," and in the northern part of Nigeria, the Hausas call it "Daidoya" [Effraim*et al*.,2003].These various regional names highlight the widespread recognition and cultural significance of *Ocimumgratissimum* in different communities.

Ocimum Sanctum

Ocimum sanctum, commonly known as holy basil (Tulsi), is a straight, branched shrub that typically reaches a height of 30-60 cm. The plant has a bushy appearance with multiple branches extending from the main stem. The leaves of *Ocimum sanctum* are arranged in a simple, alternate pattern along the stem. They are highly fragrant and emit a distinct aroma when crushed. The leaves are thick and oval-shaped, providing a lush and verdant appearance to the plant.The flowers of *Ocimum sanctum* are purple in color and have an elongated shape. They form in clusters, adding a splash of vibrant color to the plant. The flowers are not only visually appealing but also contribute to the overall aromatic experience of holy basil.As the flowers fade, small fruits develop on the plant, which are moderate in size and contain seeds[Prakash and Gupta, 2005].Holy basil, or Tulsi, holds immense cultural and religious significance in India. It is referred to by various names in different languages,

highlighting its sacred status. In Sanskrit, it is known as Vishnu-Priya Tulsi, while in Hindi, it is called Kala Tulsi. In English, it is recognized as India's Holy Basil, signifying its importance and reverence.*Ocimum sanctum* L., with its common name holy basil (Tulsi), has been valued for its medicinal properties and religious significance for centuries. It is considered a sacred plant in Hinduism and is often worshipped. The leaves of holy basil are utilized in various traditional remedies and herbal preparations due to their therapeutic potential [Yapanto, 2022].

Ocimumbasilicum

Ocimumbasilicum, more generally known as sweet basil or bhabri, is a perennial plant that grows to be fairly small, upright, and herbaceous. Its stem stands straight, is quadrangular in cross-section, and is heavily branched,providing structural support to the plant. The leaves of *Ocimumbasilicum* are ovate-lanceolate in shape, tapering to a pointed tip (acuminate). They can be either toothed or have smooth margins (entire). The leaves are smooth and hairless (glabrous) on both surfaces. They are arranged in a decussate manner, meaning they are positioned in pairs at right angles to the pairs above and below them. The color of the leaves is light green, adding to the plant's visual appeal.The inflorescence of *Ocimumbasilicum* consists of 6 to 10 small flowers arranged in whorls. These flowers are purplish white in color, creating an attractive contrast against the green foliage. Both the calyx (the outer protective covering of the flower) and corolla (the petals) are bilipped, as they have two distinct lobes. The shape of the calyx and corolla is bell-shaped. The flowers possess two pairs of stamens, and the styleis forked[Purohit and Vyas, 2008].The fruit of *Ocimumbasilicum* consists of four nutlets, which are small seed-like structures, enclosed within the mature calyx. These nutlets have an ellipsoid shape and a black color, giving them a distinctive appearance.*Ocimumbasilicum*, has gained popularity for its culinary and aromatic properties. It is widely used in various cuisines and as a savoury herb. The distinct aroma and taste of sweet basil make it a beloved herb in many culinary traditions [Prajapati *et al*., 2003].

OcimumamericanumL

Ocimumamericanum Linn, commonly known as hoary basil, rosary basil, is an erect herb with a highly branched and pubescent (covered in fine hairs) structure.These names highlight the diverse regional and cultural associations with this herb. It exhibits a range of colors from green to yellow-green, and its height can vary between 15 and 60 cm. The branches of the plant follow a sub - quadrangular striate pattern, while the stem itself has a

light puff coloration. The distinct taste of hoary basil resembles that of mint, with a refreshing flavor.This strongly aromatic herb features elliptic-lanceolate leaves that are whole, glabrous (hairless), and sprinkled with glands. The branchlets are puberulous (covered in fine hairs), and their shape can be terete or four-angular. The flowers of hoary basil are relatively small and can be white, pink, or purple in color. The nutlets produced by the plant contain narrowly ellipsoid seeds that are black and punctulate (marked with tiny pits)[Sunitha and Begum, 2013].

Ocimumtenuiflorum

Ocimumtenuiflorum, also known as holy basil, is an aromatic sub-shrub that grows erect and tall, reaching heights of 30 to 60 cm. It features hairy sub-quadrangular branches, contributing to its overall appearance. The leaves of *Ocimumtenuiflorum* are simple in structure, varying in color from green to purple. They are ovate or elliptic-oblong in shape, with obtuse or acute tips. The margins of the leaves can be slightly toothed, with entire or sub-serrate or dentate edges. Both sides of the leaves are pubescent (covered in fine hairs) and dotted. The petioles of the leaves are slender and hairy [Kumar, 2012].The stem of *Ocimumtenuiflorum* has a purple-green coloration, adding to the visual appeal of the plant. The flowers of this species are purplish white in color, displaying a combination of purple and white hues. The inflorescence consists of elongated racemes with closely arranged purplish white flowers. These flowers are hermaphrodite (having both male and female reproductive structures) and zygomorphic (bilaterally symmetrical). They form in whorls, contributing to the aesthetic appeal of the plant.The seeds of *Ocimumtenuiflorum* are brownish-reddish-yellow and have a globose to subglobose shape. The seed coat has a shiny appearance and turns mucilaginous when wetted.It is widely revered and used in traditional practices and rituals [Joseph, 2013].

The varieties of basil plant with their popular name has been mentioned in Fig.2.

Fig.2 Various species of *Ocimum*

Distribution of Tulsi plant

The geographical distribution of varieties of basil plant has been mentioned in Table-1.

Table-1: Distribution of various species of *Ocimum*

Ocimum species	**Distribution**
O.citriodorum	The use of lemon basil is common in a variety of cuisines, including Thai, Laotian, Persian, and Arabian. It is mostly cultivated in the regions of Northeastern Africa and Southern Asia for the purpose of providing a potent lemon aroma in food preparation as well as in the production of antioxidant tea bags[Janarthanam and Sumathi, 2012].
O.kilimandscharicum	Kilimanjaro and Kenya are the places in East Africa where it first appeared. Widespread in tropical and subtropical climates, including places like Rwanda, Athens, Nigeria, Ghana, Thailand, and India, amongst others. In India Cultivated in West Bengal, Assam, Tamil Nadu, Karnataka, Kerala, Dehradun, North India. Earlier observations of it were made in India, specifically in the natural

	habitats of Uttarakhand, the core zone of the Kapilash sanctuary, and other natural habitats of Odisha[Anand *et al*., 2011].
O.gratissimum	This plant can be found all throughout the Indian peninsula, as well as in Bangladesh, several nations in Africa, Thailand, Haiti,Egypt and Indonesia. In India, it is found in Tamilnadu, Bengal, Orissa, Karnataka, Kerala, Jammu and Kashmir. The Savannah and the coastal regions of Nigeria are the most likely places to find it. It is also grown domestically in Nepal, Bengal, Chittagong, and Deccan, in addition to Ceylon and the South Sea Islands[Tania *et al*., 2006].
O.santacum	The plant's origin may be traced back to India, and it is now widely cultivated and sold across the country. Plants can be found growing all the way from the Himalayas to the Andaman and Nicobar islands in India. It is extensively cultivated in certain regions of Asia and Africa[Pandey, 2010].
O.basilicum	It is believed to have originated in India in addition to other parts of Asia, as well as parts of Africa, South America, and the Mediterranean region. It is widely farmed throughout the southern, central, and eastern parts of Europe, as well as in North Africa, the United States of America, and mainly the state of California[Oliver,1980].
O. americanum	In general, it can be found all across India, particularly in the Plains, wastelands, and farms, as well as the lower slopes. It is common in arid and semiarid regions, especially near agricultural areas, and in paleotropical regions. It is only native to the continents of Africa and Asia, despite the fact that its name suggests otherwise[Sunitha and Begum, 2013].
O. tenuiflorum	It is native to India and can be found there as a cultivated plant as well as a weed that has escaped cultivation. It can be found across the whole Indian subcontinent, reaching elevations of up to 1800 metres in the Himalaya, as well as the Andaman and Nicobar islands in the south. It can be found in vast numbers across the continents of Asia, Australia, and West Africa, as well as in several Arabian nations,

	primarily in arid and sandy regions[Subramanian *et al*., 2014].

Medicinal uses of various species of *Ocimum*

Ocimumcitriodorum

One of the benefits of holy basil is its potential to help individuals suffering from early ejaculation. The plant contains certain compounds that are believed to have a positive impact on sexual health, helping to alleviate this particular concern. Holy basil has also been used to address menstrual irregularities. It is believed to have properties that can help regulate the menstrual cycle, potentially aiding individuals with late menstruation. For breastfeeding mothers, holy basil has traditionally been recommended to promote the production of breast milk. Another noteworthy property of holy basil is its role as a gas cleanser within the human body. It is believed to possess carminative properties, which means it can help alleviate gas and bloating by promoting proper digestion and reducing the formation of excess gas. Holy basil has also been recognized for its potential in treating fevers. It is believed to possess antipyretic properties, which means it can help reduce fever and provide relief from associated symptoms [Tripathi *et al*., 2014].Furthermore, studies have suggested that holy basil exhibits hepatoprotective properties, and inhibit hepatocarcinogenesis[Tripathi *et al*.,2011].

Ocimumgratissimum

In addition to its wide usage in India, holy basil, is recognized for its medicinal properties in various regions around the world.In Brazil, holy basil is known as "alfavaca" and has been traditionally used to treat a range of ailments. It is particularly valued for its effectiveness in treating upper respiratory tract infections, providing relief for symptoms such as coughing and congestion. It is also used to address digestive issues like diarrhea and alleviate headaches. Furthermore, alfavaca is employed in the treatment of ophthalmic and skin diseases, and it has been used as a remedy for pneumonia.Additionally, it is believed to have analgesic properties and is used to alleviate toothache. In cases of snake bites, alfavaca is sometimes used as a traditional treatment method [Silva *et al*., 2005].

In Kenya and other parts of sub-Saharan Africa, the leaves of holy basil are commonly used for medicinal purposes as well. The leaves are rubbed and sniffed to provide relief from blocked nostrils and nasal congestion. In addition, holy basil is used in the treatment of sore eyes and ear infections. Another traditional use of holy basil in this region is for regulating menstruation and addressing issues related to menstrual irregularities. Furthermore, it has been employed as a remedy for prolapse of the rectum [Lexa *et al*., 2007].

Ocimum sanctum

O. sanctum, has long been recognized for its therapeutic properties and is utilized in various traditional systems of medicine to treat a wide range of ailments.In the treatment of malaria, has shown promise in traditional practices. It is believed to possess anti-malarial properties and is used to alleviate the symptoms associated with this infectious disease. Additionally, holy basil is utilized to address gastrointestinal issues such as diarrhoea and dysentery. Its antibacterial and anti-diarrheal properties are valued for their potential to provide relief and promote healing. Moreover, holy basil is considered beneficial in the management of bronchial asthma, bronchitis, and other respiratory conditions. It is believed to possess expectorant and broncho-dilatory properties, helping to alleviate symptoms and improve respiratory function.

The anti-inflammatory and antimicrobial properties of this basil make it a valuable herb for addressing skin diseases. It is used to soothe skin irritations, reduce inflammation, and promote healing. In the management of arthritis, holy basil is employed for its potential analgesic and anti-inflammatory effects. It is believed to help reduce joint pain, swelling, and stiffness and provide relief from eye infections. It is employed in the treatment of colds, coughs, and influenza, providing relief from respiratory symptoms. This basil is also considered useful in addressing heart disorders and promoting cardiovascular health.Furthermore, it is utilized for mouth infections, insect bites, and stress management. Some traditional practices also suggest the use of holy basil in the management of kidney stones[Joseph, 2013].

Ocimumamericanum

In the southern state of Tamil Nadu in India, is locally referred to as Naithulasi, and American tulsi. Its leaf extract decoction has been traditionally used for various health conditions. The decoction of this basil leaves is believed to possess medicinal properties that can help in the treatment of constipation, diabetes, dysentery, diarrhea, and piles (haemorrhoids). The use of this basil as a natural remedy for these digestive issues reflects its potential as a mild laxative, antidiabetic, and antimicrobial agent.

In East Africa, specifically in regions where *Ocimumamericanum*is found, extracts of this variety of holy basil are used in the treatment of ulcers. It is believed to possess properties that help in the healing of ulcers and provide relief from related symptoms. Additionally, holy basil extracts from this region are used as an anticathartic agent, which can

aid in relieving constipation and promoting bowel movements.The plant is known to have a lowering effect on high blood pressure, and its use is valued in managing this cardiovascular condition. In different regions, these basil decoctions have been traditionally used to address various health concerns. These include treating coughs, ear and eye complaints, haemorrhoids, tuberculosis, and stomach pains. The specific properties of holy basil, such as its antimicrobial, anti-inflammatory, and expectorant effects, may contribute to its effectiveness in these applications[Ali *et al*., 2022;Anusmitha*et al*., 2022].

Traditional uses of various species of *Ocimum*

Ocimumkilimandscharicum

In East Africa, the traditional use of extracts from *Ocimumkilimandscharicum*Guerke, commonly known as Kapurtulsi, has been employed to address various disorders. This includes the treatment of coughs, colds, measles, abdominal pains, diarrhea, and as an insect repellent, particularly against mosquitoes and storage pests. The essential oils derived from this plant have been utilized for centuries in North-Eastern Tanzania as a repellent against nuisance biting insects and malaria vectors, showcasing its long-standing effectiveness in mosquito control.

In the Indian system of medicine, known as Ayurveda, *Ocimumkilimandscharicum* (Kapurtulsi) has been valued for its diverse properties. It has been used as an anti-inflammatory agent, aids in digestion, acts as an insecticide and mosquito repellent, and is appreciated for its aromatic qualities. The entire plant of *Ocimumkilimandscharicum* is utilized as a spasmolytic and exhibits antibacterial properties. The decamphorized oil obtained from its leaves has been employed as an insecticide and mosquito repellent. Furthermore, the essential oil derived from *Ocimumkilimandscharicum* (Kapurtulsi) is utilized in the preparation of portable liquid disinfection, as indicated by a United States Patent (No. 7074439).

Basil, in general, has a rich history as a popular culinary and medicinal herb, with its usage dating back to ancient times and continuing to the present day. The leaves and flowers of basil have been utilized for various purposes, including the treatment of headaches, coughs, diarrhea, worms, and kidney malfunctions. It is recognized for its carminative, galactagogue, stomachic, and antispasmodic properties. Additionally, the essential oils extracted from basil are widely employed in the flavouring of food and in perfumery due to their aromatic properties.

It is important to note that while basil has a long-standing tradition of culinary and medicinal use, scientific research continues to explore its potential benefits and mechanisms of action. The diverse therapeutic properties attributed to basil are a subject of ongoing investigation and validation.

Ocimumgratissimum

Ocimumgratissimum, commonly known as clove basil or African basil, has a rich history of traditional medicinal use in various countries. In the north-eastern region of Brazil, it is utilized for its medicinal, condiment, and culinary properties. The flowers and leaves of this plant are particularly rich in essential oils, making them suitable for the preparation of teas and infusions, which are used as pulmonary antiseptics, antitussives, and antispasmodics.

In coastal areas of Nigeria, *O. gratissimum* is employed in the treatment of epilepsy, high fever, and diarrhoea. In the savannah regions, decoctions of the leaves are used to address mental illness. Among the Ibos of south-eastern Nigeria, the plant is utilized in the management of the baby's umbilical cord to maintain sterility. It is also employed in the treatment of fungal infections, fever, colds, and catarrh. In the Brazilian tropical forest, a decoction of *O. gratissimum* roots is used as a sedative for children.

Communities in Kenya and sub-Saharan Africa utilize *O. gratissimum*for various purposes. The leaves are rubbed between the palms and sniffed to alleviate blocked nostrils. They are also employed in the treatment of abdominal pains, sore eyes, ear infections, coughs, infertility, fever, convulsions, and as a tooth gargle. Furthermore, the plant is used to regulate menstruation and as a remedy for rectal prolapse.

In India, the entire *O. gratissimum* plant has been utilized for the treatment of sunstroke, headaches, influenza, and for its diaphoretic, antipyretic, and anti-inflammatory properties. Nigerian tribes employ the leaf extract to treat diarrhea, while cold leaf infusions are used to relieve stomach upset and hemorrhoids. Additionally, *O. gratissimum* is commonly used in folk medicine to address upper respiratory tract infections, diarrhea, headaches, eye diseases, skin diseases, pneumonia, coughs, fevers, and conjunctivitis. It is important to note that while *O. gratissimum* has a long history of traditional use, further scientific research is necessary to fully understand its potential benefits and mechanisms of action. The traditional uses mentioned above serve as a starting point for exploration and validation in the context of modern medicine.

Ocimum sanctum

Ocimum sanctum, also known as holy basil or Tulsi, offers various therapeutic applications. Apart from its traditional use as a herbal tea, it is consumed to alleviate symptoms of cough, cold, and malaria.

Ocimumamericanum

In Africa, the leaves of *O. americanum* are utilized as a natural insecticide to protect crops from post-harvest insect damage, particularly by bruchid beetles. The plant itself possesses carminative, diaphoretic, and stimulant properties, making it useful in addressing conditions such as colds, coughs, and bronchitis. The leaf juice is employed in treating dysentery and as a mouthwash to relieve toothaches. It is also poured into nostrils to alleviate migraines. Decoctions of the leaves are used to control nosebleeds and malarial fever. Additionally, leaf paste serves as a remedy for parasitical skin diseases. The tea or infusion made from the leaves is administered to individuals experiencing fever, indigestion, and diarrhea. Moreover, the dried plant is burnt as a mosquito repellent.Extracts derived from *O. americanum* are not only used for tea but also applied in flavoring tobacco and as a body fragrance. The aromatic herb's leaves can be crushed between the palms and sniffed or inhaled as hot aqueous vapor to clear blocked nostrils and alleviate bronchial congestion.

Value addition fromtulsi

Air pollution tolerance index (APTI) was analysed for 25 plant samples including *Ocimumtenuiflorum*collected from industrial, urban and rural areas. Among 25 plants Artocarpus heterophyllus secured highest APTI value (46.74) whereas *Ocimumtenuiflorum* showed lowest APTI value (11.32-12.86) [Patil*et al*., 2023].

Tulsi leaves were employed to create smart magnetically retrievable fluorescent nanohybrid by fabricating highly fluorescent carbon dots on NiFe2O4 surfaces. These nano particles detect and eliminate harmful pollutants in aqueous samples via photo-Fenton degradation. This novel method allows for monitoring and eradication of pollutants for human safety. The intelligent nanohybrid, made up of Tulsi leaves carbon dots and NiFe2O4, was employed for methodical photoluminescence-based detection and removal of nitroexplosives, antibiotics, and pesticides[Kaur *et al*., 2023].

Anti-corrosion property of green tea and tulsi extracts were examined against aluminium alloy in alkaline medium (10% NaOH). Investigation showed that both green tea and tulsi extract have good corrosion inhibition efficacy, but tulsi was more effective than green tea [Chowdhury*et al*., 2023].

Clove and Tulsi were supplemented for growth of broiler and gut health alternative to antibiotic growth promoters. Since use of antibiotics causes raising of antibiotic resistant pathogenic bacterial population and contamination of edible meat tissue with these antibiotics. Result of the study endorsedthat utilization of tulsi and clove in combinationhave positive effect on broiler health and production of good quality meat. Therefore,tulsi can be used for the production of broiler in organic production system[Sultana *et al*.,2023].

The sensory properties of functional beverages made from tulsi leaves were investigated to identify which attributes boost customer adoption. Three tulsi beverage samples compared for aroma and taste when blended with ginger, citrus lime, lemongrass, mint, honey, sweetness, and aftertaste were found to be favourably associated with customer likeliness. This study could be used as a preliminary study for designing novel functional beverage products based on the sensory features and critical attributes of tulsi leaves[Ervina and Marvell, 2023].

The effect of edible coating on tomato forthe weight loss, TSS, TA, PH of tomato was examined after incorporation of tulsi extract to it by volume of 1%, 2% and 3% in every 5 days interval upto 20 days. Out of three treatment, 3% supplementation of tulsi extract was found to be best for the increase of shelf life of tomatoes[Begum *et al*., 2007].

Guava nectar was prepared with aonla and tulsi extract.Out of 12 treatments, the nectar containing 60% guava, 40% anola, 5ml tulsi, 20% fruit juice with TSS 15 Brix and 0.3% acidity secured highest score for colour, taste, Flavour, texture and overall acceptability [Gaikwad, 2022].

The mulberry blended juice was prepared with additional herbs like basil and mint. Out of 8 different treatments, the biochemical, therapeutic and sensory properties of mulberry blended juice with 3% ginger, 8% basil and 16% mint was found to be best among all the treatment under study. The product has good source of TPC,TFC, anthocyanin and total antioxidant capacity then the control mulberry juice [Parida *et al*., 2021].

Gooseberry based jam, squash, candy and murabba were substituted with basil leaves in 3 proportions, i.e. 5, 10 and 15 g. Out of which 10g incorporation of tulsi leaves was found to be appreciable in Jam, Murabba and Candy. However,in squash 15g of tulsi was also acceptable[Saxena and Chaturvedi, 2015].The experiment revealed pineapple slices with 70% sugar and 10% basil leaves were the best herbal Pineapple Candy product, with the highest organoleptic and physico-chemical attributes. Pineapple candy can be stored up to 90 days, retaining its optimum quality and market value[Arya A, Joseph AV, 2023].

Jaggery, a natural sweetener with numerous nutritional and medicinal properties, is standardized for quality analysis using krishnatulsi (*Ocimumtenuiflorum*) powder and aqueous extraction. Results showed that a 2.0% tulsi powder concentration was the best accepted for appearance, color, texture, taste, flavor, and overall acceptability, suggesting its potential for general health and nutritional benefits[Kolar and Jamuna, 2022].

Fruitbased soy milk fortified yoghurt was developed with supplementation of tulsi leaf extract in different proportion. The result of the analysis revealed that Yoghurt prepared using 10% soy milk 15% mango pulp & 1% tulsi leaf extract was best out of all the treatments [Jaglan*et al*., 2018].

Tulsi extract was incorporated in herbal Shrikhand formulation to enhance the functional value of it. The best combination for development of Shrikhandwas found to be 0.9% tulsi extract and 40% sugar. Incorporation of tulsi extract increased the flavour, taste, protein, ash and moisture content of Shrikhand significantly[Rai *et al*., 2018].

Herbal lassi was developed withsupplementation of honey and tulsi extract in different ratios. Out of all combinations, the mixture of 2.0%tulsi extract and 10.0% honey was found to be the most suitable for development of herbalhoney Lassi [Kumar *et al.*, 2020].

Herbal Sandesh was prepared by incorporating medicinal plant Ashwagandha root extract (0-3%) and Tulsi leave extract (0-3%). Where the incorporation of 2 % Ashwagandha and 2 % tulsiwas secured highest score in preparation of herbal sandesh. The cost of which was estimated to be Rs.254.29/kg [Husain *et al*., 2017].

Basil juice and freezedried basil powder were incorporated in ice cream mixture in different ratios. Among all the treatments addition of 6% basil juice and 1% of basil powder were recommended in manufacturing of ice cream [Tridevi*et al*., 2014].

Composite flours of blanched pearl millet, sorghum, dehusked oat and germinated chickpea was used to make six types of chapattis in different proportions. Three types of chapattis were made using only composite flours where as in another three types of chapattis,tulsi leaves was mixed.Though composite flour made chapattis found to be superior in terms of nutritional value but addition of tulsi leaves further enhanced the nutrient value of composite flour made chapattis [Dahiya, 2020].

Pasta, vermicelli and macroni were prepared from blended flours of maize:oat:tulsi in ratio of 80:15:5, 65:30:5, 50:45:5 (W/W). Out of which pasta, vermicelli and macroni developed from 65:30:5 blend flours were most acceptable. It was also found that supplementation of

tulsi significantly enhance the crude fiber and ash content of products compared to un-supplemented and control products[Narwal, 2017].

Herbal biscuit containing holy bail and moringa leaves was compared with normal biscuit on the basis of protein,fiber, fat, carbohydrate, ash contents and energy value. Result of theexperiment showed that addition of tulsi and moringa leaves enhance the acceptance of biscuit [Alam *et al*., 2014].

Mutton meat ball was incorporated with 0.1%, 0.2% and 0.3% of tulsi leaf extract, as natural antioxidant. Incorporation of 0.3% of tulsi leave extract with mutton meat ball was found to be suitable on the basis of biochemical, microbial and nutrient quality at refrigerated preservation[Rahman, 2023].

The sensory, physicochemical, biochemical and microbiological parameters were determined for beef meatballs, which was supplemented with tulsileaf extract by 0.1, 0.2 and 0.3%. Formulation with 0.2% of tulsi leaf extract was found to be suitable on the basis of nutrient quality, physicochemical properties, biochemical analysis and microbial analysis. However, 0.3% tulsi leaf extract is more reasonable as a source of natural antioxidant than that of other treatment groups[Siddiqua *et al*., 2018].

Herbal cookies were developed by replacing whole wheat flour with tulsi leave and giloystem powder. 1.5gm of giloy stem powder and 3gm of tulsi leaves powder were found to be best for preparation of cookies among all the treatments on the basis of sensory parameters[Gawade, 2023].

Conclusion

In Sanskrit, the word "tulsi" denotes "one that is unmatched or unmatchable". This herb was so effective in promoting health and healing that it was worshipped as a deity. Tulsi continues to play a significant role in healing, religion, spirituality, culture, and decorative aesthetics. Tulsi, also known as the Queen of Herbs, has a strong scientific foundation in treating various ailments. The extensive morphological variations observed within the genus *Ocimum*highlight the genetic diversity and adaptability of these plants. The interplay of geographic factors, polyploidy, interspecific hybridization, and changes in generic descriptions has contributed to the rich assortment of basil varieties, each with its unique

combination of traits. Its antibacterial, anti-inflammatory, ulcer-healing, antioxidant, and immunomodulatory properties make it potential for various disease treatment. These variations make basils not only visually appealing but also versatile in their culinary, medicinal, and ornamental applications.

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