



REVIEW ARTICLE

ORIGIN, TAXONOMY, BOTANICAL DESCRIPTION, GENETICS AND CYTOGENETICS, GENETIC DIVERSITY, BREEDING AND CULTIVATION OF BASIL

*K.R.M. Swamy

Retd. Principal Scientist & Head, Division of Vegetable Crops, ICAR-Indian institute of Horticultural Research, Bangalore-560089

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ABSTRACT

Basil belongs to the family Lamiaceae, genus *Ocimum* and species *O. Basilicum*. The species is also known as *Ocimum tenuiflorum*. English names are sacred basi, holy basil. In Assamese : Tulasii, Hindi : Bawari, bawari, Ban thulasi, Tulsi, Bengali: Babui tulsi, Gujarati : Sabje, Kannada : Amlu, Huli, Malayalam: Pachcha/sivatulasi, Marathi: Sabja/Tulasa, Oriya : durlabha, Punjabi : Imli, Tulasigidda, Tulasi, Sanskrit : Barbari, Bana thulasi, Tungi, Tamil :Tulasi, Tirunirippachai, Telugu : Tulsi-chettu, Urdu : Imli. Basil, one of the most popular herbs grown in the world, is native to Asia (India, Pakistan, Iran, Thailand, and other countries) and can be observed growing wild in tropical and sub-tropical regions. Because of the popularity of basil, the plant is often referred to as the “king of the herbs.” Several name derivations and beliefs are associated with basil, but the common name basil is probably derived from the Greek words *basileus* meaning “king” or *basilikon* meaning “royal.” A Latin word, *basiliscus*, refers to “basilisk” a mythical fire-breathing dragon so repulsive that a glance could kill. According to a Roman legend, basil was the antidote to the venom of the basilisk. The botanical name *Ocimum* is derived from the Greek meaning “to be fragrant.” In the 1600s, the English used basil as a food flavoring and insecticide. The plant was hung in doorways to ward off flies and other unwanted pests (evil spirits). Basil is obtained from the foliage of *Ocimum basilicum* L. (sweet basil), an annual herbaceous plant up to 100 cm in height. It is native to tropical Asia, Africa and America and widely cultivated in pots and gardens in Europe, South-west Asia and the USA. The leaves are ovate and vary in size, depending on the cultivated variety, from the small leaves of the common basil to the large leaves of lettuce leaf basil. The verticillasters of the white or pink flowers are arranged in terminal racemes. Different cultivated forms, considered distinct by herbalists (e.g., *O. minutum* L.), are not recognized taxonomically. The dried sweet basil leaves have a sweet, fragrant odor, and their taste is aromatic, warm, and slightly pungent. Basil is considered as the finest of all aromatic herbs and is widely used to flavor cooked vegetables, tomato-paste products, and fish. It is sometimes used with, or as a substitute of, oregano to flavor pizza and spaghetti sauce and is employed together with other spices in the manufacture of vinegar, mustard, and sausages. Though not used in large quantities, sweet basil oil is used quite extensively in the flavoring of several food products, including those for confectionery, alcoholic beverages (liqueurs), baked goods, and condiments. The commercial essential oils are usually methyl-chavicol (an isomer of anethole) and/or linalool rich. However, *O. basilicum* oils are particularly variable and may also have high amounts of methyl-cinamate, geraniol, eugenol, and methyl-eugenol. In this review article on Origin, Taxonomy, Botanical Description, Genetic Diversity, Breeding and Cultivation of Basil are discussed.

*Corresponding author:
K.R.M. Swamy

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INTRODUCTION

Basil belongs to the family Lamiaceae, genus *Ocimum* and species *O. basilicum* (Sullivan, 2009; AFF, 2012; Wikipedia, 2024; Plants. 2024; Petruzzello, 2024; NWE, 2024; USDA, 2024; Bashyal, 2024;). The species is also known as *Ocimum tenuiflorum*. English names are sacred basi, holy basil. Indian names are in Assamese : Tulasii, Hindi : Bawari, bawari, Ban thulasi, Tulsi, Bengali: Babui tulsi, Gujarati : Sabje, Kannada : Amlu, Huli, Malayalam : Pachcha/sivatulasi, Marathi : Sabja/Tulasa, Oriya : durlabha, Punjabi : Imli, Tulasigidda, Tulasi, Sanskrit : Barbari, Bana thulasi, Tungi, Tamil :Tulasi, Tirunirippachai, Telugu : Tulsi-chettu, Urdu : Imli (SBI, 2024). Foreign names are Spanish : Alba Laca, French : Basilic, German : Basilienkraut, Swedish : Basilkort, Arabic : Raihan, Dutch : Basilicum, Italian : Basilico, Portuguese : Manjericao, Russian : Basilik, Japanese : Meboki, Chinese : Lo-le, Thai : Horapa, Horapha, English : Sweet Basi

(SBI, 2024). Different derived names in different languages include Barsegh in Armenian; Basile in French; Basilius in German; Basilio in Italian and Spanish; Basílio in Portuguese; Basileo in Galician; Vasyll in Ukraine; Vasile in Romanian; Vasil in Bulgarian; Vasilije in Serbian; Vasily in Russian; Bazil, Bazsó, Vászoly and Vazul in Hungarian (Wikipedia, 2024).

Basil, one of the most popular herbs grown in the world, is native to Asia (India, Pakistan, Iran, Thailand, and other countries) and can be observed growing wild in tropical and sub-tropical regions. Because of the popularity of basil, the plant is often referred to as the “king of the herbs.” Several name derivations and beliefs are associated with basil, but the common name basil is probably derived from the Greek words *basileus* meaning “king” or *basilikon* meaning “royal.” A Latin word, *basiliscus*, refers to “basilisk” a mythical fire-breathing dragon so repulsive that a glance could kill. According to a Roman legend, basil was the antidote to the venom of the basilisk. The botanical name *Ocimum* is derived from the Greek meaning “to be fragrant.” In the 1600s, the English used basil as a food flavoring and insecticide. The plant was hung in doorways to ward-off flies and other unwanted pests (evil spirits) (Olga and Spiridon, 2008).

Basil belongs to the genus *Ocimum*, derived from the Greek *ozo* which means to smell, in reference to the strong odors of the species within the genus. In French, it is frequently given the name “Herbe Royale,” revealing the positive light in which it is viewed. The etymology of basil is unclear, however several potential sources are plausible. It is sometimes referred to as “the king of herbs,” and may have been derived from the Greek *basileus*, or king. Basil’s affiliation with the crown may be in part due to its use in regal medicine. Basil may come from the Latin *basilisk*, or dragon; this etymological connection may explain the symbolic connection between basil and scorpions (Sullivan, 2009). The name “basil” comes from the Latin *basilius*, and the Greek βασιλικόν φυτόν (*basilikón phytón*), meaning “royal/kingly plant”, possibly because the plant was believed to have been used in production of royal perfumes. Basil is likewise sometimes referred to in French as “*l’herbe royale*” (‘the royal herb’). The Latin name has been confused with basilisk, as it was supposed to be an antidote to the basilisk’s venom (Inaturalist, 2024). The name “basil” comes from the Latin *basilius*, and the Greek βασιλικόν φυτόν (*basilikón phytón*), meaning “royal/kingly plant”, possibly because the plant was believed to have been used in production of royal perfumes. Basil is likewise sometimes referred to in French as “*l’herbe royale*” (‘the royal herb’). The Latin name has been confused with basilisk, as it was supposed to be an antidote to the basilisk’s venom (Wikipedia, 2024). The name Basil (*royal, kingly*) comes from the male Greek name Vassilios (Greek: Βασίλειος, female version Βασιλεία), which first appeared during the Hellenistic period. It is derived from “*basileus*” (Greek: βασιλεύς), a Greek word of pre-Hellenic origin, meaning “king”, from which words such as basilica and basilisk (via Latin) as well as the eponymous herb basil (via Old French) derive, and the name of the Italian region Basilicata, which had been long under the rule of the Byzantine Emperor (also called *basileus*) (Wikipedia, 2024).

Basil is one of the most popular herbs grown in the world. It is native to Asia (India, Pakistan, Iran, Thailand and other countries) and can be found growing wild in tropical and sub-tropical regions of the world. Because of its popularity, basil is often referred to as the “king of the herbs” (Rindels, 1997). Basil has several name derivations and beliefs associated with it. The common name basil may be derived from the Greek words *basileus* meaning “king.” or *basilikon* meaning “royal.” A Latin word, *basiliscus*, refers to “basilisk” a mythical fire-breathing dragon that was so repulsive it could kill with just a glance (Rindels, 1997). According to Roman legend, basil is the antidote to the venom of the basilisk. The botanical name *Ocimum* is derived from the Greek meaning “to be fragrant” (Rindels, 1997). In the 1600’s, the English used basil as a flavoring in their food and also as an insecticide. It was hung in doorways to ward off flies and other unwanted pests (evil spirits). Italians used basil as the sign of love. A pot of basil placed on the balcony meant that a woman was ready for her suitor to arrive. And, if he brought a sprig of basil, she would fall in love with him. It was also worn by a courting young man to signal to a woman that he had serious intentions (Rindels, 1997). In India, Hindus believed that if a leaf of basil was buried with them, it would get them into heaven, thus the popularity of holy basil. Basil was also sacred to the Gods in India, Krishna, and Vishnu. In America, basil has been grown for over 200 years. It was air dried or preserved in layers of salt and kept in earthenware crocks (Rindels, 1997). Basil has many uses, the most common of which is its culinary use. As a fresh herb, it is used to flavor foods such as vegetables, poultry, and fish. It is famous for use in Italian dishes such as pesto. Basil is commonly preserved in vinegar or olive oil and adds a delightful flavor to both for salad dressings. It is also used for flavor in jelly, honey, tea, and liquor. Basil can also be used dried. The flowers of basil are also edible and can be an attractive addition to salads and other dishes (Rindels, 1997). Besides its edibility, basil is an aromatic herb and is often used in potpourri and sachets. The cosmetic industry uses basil oil in lotion, shampoo, perfume, and soap. As an ornamental in the flower garden, basil has attractive foliage and flowers (Rindels, 1997). Basil is a tender perennial grown as an annual. It can be grown easily from seed. Start seed indoors 4 or 5 weeks before the last frost date. It likes warm temperatures (about 75 F) for germination. Seed can also be sown directly in the ground outdoors after it has warmed in the spring. Plant basil outdoors after all danger of frost is past. Basil does not tolerate cold temperatures. Plant in full sun and avoid heavy nitrogen fertilization. Too much nitrogen affects oil content and flavor. Water regularly with an inch of water a week. Basil can also be propagated vegetatively through tip cuttings. Root cuttings in moist perlite or coarse sand (Rindels, 1997). To harvest, remove terminal growth whenever four sets of true leaves can be left on the plant. This encourages bushier growth and increased yield. For best foliage flavor, cut before flowering. Leaf flavor changes after flowers open. After cutting, wash and pat leaves dry. Use immediately or store in perforated plastic bags in the refrigerator. When drying the leaves, harvest early in the day but after dew has dried. Spread leaves on screens or loosely bundle and air dry. Warm air circulation (less than 130 F) aids color retention. Sun dried leaves tend to be brownish in color (Rindels, 1997). Basil is a member of the mint family which is characterized by square stems. They belong in the genus *Ocimum*. Several different species are grown, the most common being *basilicum*. Over 150 different species and varieties are available (Rindels, 1997). Basil is obtained from the foliage of *Ocimum basilicum* L. (sweet basil), an annual herbaceous plant up to 100 cm in height. It is native to tropical Asia, Africa and America and widely cultivated in pots and gardens in Europe, South-west Asia and the USA. The leaves are ovate and vary in size, depending on the cultivated variety, from the small leaves of the common basil to the large leaves of lettuce leaf basil. The verticillasters of the white or pink flowers are

arranged in terminal racemes. Different cultivated forms, considered distinct by herbalists (e.g., *O. minutum* L.), are not recognized taxonomically (Kokkini *et al.*, 2003). The dried sweet basil leaves have a sweet, fragrant odor, and their taste is aromatic, warm, and slightly pungent. Basil is considered as the finest of all aromatic herbs and is widely used to flavor cooked vegetables, tomato-paste products, and fish. It is sometimes used with, or as a substitute of, oregano to flavor pizza and spaghetti sauce and is employed together with other spices in the manufacture of vinegar, mustard, and sausages. Though not used in large quantities, sweet basil oil is used quite extensively in the flavoring of several food products, including those for confectionery, alcoholic beverages (liqueurs), baked goods, and condiments. The commercial essential oils are usually methyl-chavicol (an isomer of anethole) and/or linalool rich. However, *O. basilicum* oils are particularly variable and may also have high amounts of methyl-cinnamate, geraniol, eugenol, and methyl-eugenol (Kokkini *et al.*, 2003).

Italians used basil as the sign of love and a pot of basil placed on the balcony meant that a woman was ready for her suitor to arrive. In turn, if he brought a sprig of basil, he would signal to her his serious intentions. Hindus believed that being buried with a leaf of basil meant they would get into heaven. According to the ancient Greeks, basil represented hate and misfortune. Poverty was painted as a ragged woman with basil at her side with the thought the plant would not grow unless railing and abuse were poured forth at the time of sowing. The Romans, in like manner, believed that the more basil was abused, the better the plant would prosper (Olga and Spiridon, 2008). The physicians of old were quite unable to agree as to the medicinal value of basil, although some declared the plant was a poison and others said the plant was a precious sample (a medicinal plant). Basil was sacred to the gods in India, Krishna, and Vishnu. In America where basil has been grown for over 200 years, the plant was originally air-dried or preserved in layers of salt and kept in earthenware crocks (Olga and Spiridon, 2008). Basil has many uses, but the most common is for culinary purposes. As a fresh herb, basil is used to flavor foods such as vegetables, poultry, and fish. The herb is famous for use in Italian dishes, such as pesto. Basil is commonly preserved in vinegar or olive oil and adds a delightful flavor to both for salad dressings. The plant is also used as a flavoring in jelly, honey, tea, and liquor. Basil can also be used dried (Olga and Spiridon, 2008). The flowers of basil are edible and can make an attractive addition to salads and other dishes. Besides being edible, basil as an aromatic herb is often used in potpourri and sachets. The cosmetic industry uses basil oil in lotions, shampoos, perfumes, and soaps. As an ornamental in the flower garden, basil has attractive foliage and flowers (Olga and Spiridon, 2008). Basil is a source of essential oils and aroma compounds, a culinary herb, and an attractive, fragrant ornamental. The seeds contain edible oils and a drying oil similar to linseed oil. Extracts of the plant are used in traditional medicines, and have been shown to contain biologically active constituents that are insecticidal, nematocidal, fungistatic, and antimicrobial. For example, the essential oils of *O. forskolei* Benth are mosquito-repellent, while methanol extracts of *O. gratissimum* have been used for the control of *Leishmania*, *Candida*, and *Cryptococcus* species. The trypanocidal activity of essential oils from *O. basilicum* has also been demonstrated. According to a recent report, sweet basil oil gave the highest anti-proliferative activity among 17 different Thai medicinal plant species against the murine leukemia P388 cell line. In addition, aqueous extracts of *O. sanctum* has demonstrated significant mammary immunostimulant activity (Olga and Spiridon, 2008). In common with other members of the Lamiaceae family, basil, both wild and sweet, furnishes an aromatic, volatile, and camphoraceous oil that is much employed in France for flavoring soups, especially turtle soup. The French also use basil in ragouts and sauces. Leafy tops of basil are thought to be a great improvement to salads and cups. Although not commonly used in England for culinary purposes, this basil was a favorite pot-herb in the past and gave rise to the distinctive flavor that made Fetter Lane sausages famous (Olga and Spiridon, 2008).

For the fresh market, basil should have a sweet flavor and dark green foliage. Commercially, three major types of basil with essential oil or dried leaves as the end product are used. French basil, reputed to be sweetest in flavor and darkest in color, is the most valued. American basil, noted for rich color, sweet flavor, cleanliness, and uniformity of particle size, is considered to be of high quality. Egyptian basil, also known as "Reunion" or "African" basil, has a somewhat camphoraceous fragrance and unusual flavor to some palates and is thus considerably less valued in the market (Olga and Spiridon, 2008). While basil seed is plentiful, care must be observed in obtaining a type that has desirable characteristics. Because several basil types may be mixed together by a seed house or processor to achieve a desired blend, any collected seeds that are later sown may vary in growth, development, and aromatic properties (Olga and Spiridon, 2008). Though generally employed in cooking for flavoring, basil has been occasionally used for mild nervous disorders and for the alleviation of wandering rheumatic pains. The dried leaves, in the form of snuff, are said to be a cure for nervous headaches and, indeed, research has provided some evidence for a direct effect of basil constituents on the central neural system. For example, leaf-derived ethanolic extracts of *O. sanctum* have been shown to cancel the noise stress-induced reduction in total acetylcholine content and increase the activity of acetylcholin-esterase in the cerebral cortex, corpus striatum, hypothalamus, and hippocampus of brain, possibly through the exertion of antioxidant activity. These properties have been partly attributed to volatile compounds in the plant, such as the sesquiterpenes eugenol and 1,8-cineole in *O. gratissimum*, that are subject to seasonal variation. An infusion made with the fresh herb is good for obstructions of the internal organs and arrests vomiting and allays nausea. The seeds are thought to be efficacious against the poison of serpents when taken internally or laid upon the wound. Seeds are also said to cure warts (Olga and Spiridon, 2008).

Basil leaves are widely used for flavouring purposes in soups, meat pies, fish dishes, certain cheeses, tomato salads, cooked cucumber dishes, cooked peas, squash, and string beans as well as vinegars and oils. Chopped basil may be sprinkled over lamb chops before cooking. Basil is an important seasoning in tomato paste products in Italy, and is often used with or as a substitute for oregano in pizza toppings, spaghetti sauces, meat balls, or in macaroni and cheese bakes (Pushpangadan and George, 2012). The essential oil of *O. basilicum* obtained by distillation is used in a number of food products as a flavouring agent and is also used in perfumery thanks to its aromatic characteristics. It contains cineol, pinene, methyl chavicol, d-camphor and ocimene. The major aroma constituents of basil are 3,7-dimethyl-1,6-octadien-3-ol (linalool; 3.94 mg/g), 1-allyl-4-methoxy benzene (estragole; 2.03 mg/g), methyl cinnamate (1.28 mg/g), 4-allyl-2-methoxyphenol (eugenol; 0.896 mg/g), and 1,8-cineole (0.288 mg/g) (Pushpangadan and George, 2012).

Examples of food products that may be flavoured with basil essential oil include confectionery, baked goods, condiments, spiced meats, ice creams, puddings, liquors and non-alcoholic beverages. The oil may also be used as a flavouring for certain dental and oral hygiene products (Pushpangadan and George, 2012). Basil (*Ocimum basilicum*, Lamiaceae) (also known as sweet basil) is an annual spicy herb, indigenous to India. Several species of *Ocimum* are cultivated in India, where their medicinal and aromatic uses have been known for several millennia. The ancient Ayurvedic surgeon Sushruta classified *Ocimum* as a green leafy vegetable, while Bhavamisra, a famous Ayurvedic Acharya, referred to *Ocimum basilicum* as 'barbari'. It is also mentioned in classical Ayurvedic texts such as *Sushruta Samhita*, *Charaka Samhita*, *Bhavaprakasham*, and *Ashtangahridayam*, among others. Sweet basil is native to India and tropical Asia, and now grows wild in tropical and sub-tropical regions including Central Africa and South East Asia. It is cultivated commercially in many warm and temperate countries worldwide, including France, Hungary, Greece and other southern European countries, Egypt, Morocco and Indonesia. It is also cultivated in several US states, including Arizona, New Mexico and North Carolina, as well as in California, where a superior quality of leaf is grown (Pushpangadan and George, 2012a).

The family Lamiaceae (often called Labiatae, the traditional name) is a large family, comprising about 200 genera and 3,200 species which are widely distributed almost all over the temperate and tropical regions, but centered in the Mediterranean region. The typical characteristics of this family are a square stem, opposite and decussate leaves with many gland dots. The flowers are strongly zygomorphic with two distinct lips. Many species of the family are strongly aromatic due to essential oils which consist of monoterpenes, sesquiterpenes and phenylpropanoids (Nassar *et al.*, 2013). *Ocimum* is one of the most important genera of the family Lamiaceae, native to India, Southern Asia and Middle East. Cultivated extensively in Southern, Central and Eastern Europe, North Africa, and in the USA, particularly California (Nassar *et al.*, 2013). Economically, it is of great importance as a source of volatile aromatic oils, medicines and ornamentals. There are about 150 to 160 species in this genus broadly dispersed over the warm regions of the globe. They differ in growth habit, physiological appearance and chemical and aromatic composition. They grow in wide variety of soil and climatic conditions. The morphology of *Ocimum* varies from herb to subshrubs with large variations in leaf shape, size, hairs, glands and many more morphological peculiarities. All *Ocimum* species yield essential oils which is responsible for the medicinal uses including antimicrobial, antioxidant, antifungal and anti-inflammatory activities; yet their taxonomy and nomenclature are in a bit of muddle. Thus, any new information about *Ocimum* plants are urgently to be welcomed (Nassar *et al.*, 2013). In this respect, *Ocimum basilicum* L. (Sweet Basil or Basil) called Rehan in Arabic was chosen to be the subject of the present investigation because of its economic importance as an ornamental, spice, culinary and medicinal herb. The name Basil is derived from Greek word *basileus* which means "king", because of the royal fragrance of this herb (Nassar *et al.*, 2013). The Basil is very aromatic herb. The stems are square in cross-section and branch profusely. The stalked leaves are arranged in a decussate manner, where the arrangement of a pair of opposite leaves intersects the next to form a cross and so on. About 6 to 10 small flowers are arranged in whorls at the nodes of the inflorescence. Both the calyx and corolla are bell-shaped. The calyx has two lips and the upper lip is usually broad; the lower lip usually has four narrow pointed teeth and is not curved backwards. The flower stalk is shorter than the calyx, bent upright and appressed against the inflorescence axis. The corolla also has two lips with a longer lower lip, 7 to 9 mm long and white or violet in colour. There are two pairs of stamens and the style is forked. The fruit consists of four nutlets enclosed in the mature calyx. The fruiting calyx measures 5 to 9 mm long. Sweet Basil (Tulsi) is an annual herb with a square branched stem and numerous opposite, stalked, ovate, slightly toothed and glabrous leaves, often reddish in colour. The small white, yellowish or pinkish flowers are arranged in whorls in the upper leaf axils. The fruit consists of four nutlets. All parts of the plant are hairy and aromatic. Basil is an erect, almost glabrous herb, 30-90 cm high, leaves ovate-lanceolate, acuminate, toothed or entire, glabrous on both surfaces. Flowers white or pale purple, in simple or much-branched racemes, often thysoid. Nutlets ellipsoid, black and pitted (Nassar *et al.*, 2013).

The oldest origin of the word "basil," according to the OED, is the ancient Greek *basileus*, meaning "king" (the same root as "basilica," which originally referred to a royal doorway). The OED speculates that this might be because the herb was used "in some royal unguent, bath, or medicine" (a basil bath does sound pretty decadent), but there isn't much evidence for that, especially since, in ancient Greece, the idea of "poverty" was personified as a ragged woman with basil growing at her side (Dean, 2013). Another possible explanation for the kingly connection comes from the story of St. Helena, the mother of Constantine. Medieval versions of the legend say that Helena was led to the site of the True Cross by following a trail of basil, which had sprung up wherever the blood of Jesus had fallen during his crucifixion. One account even describes basil actually growing out of the chunk of the Cross itself. But earlier accounts don't mention the basil connection at all, so it's hard to say whether basil got named after the King of Kings, or if it was just added to the story later as a kind of herbal-mystical pun--after all, John writes that basil's Greek root, *basileus*, was written on the Cross, as part of the phrase *Iesous o Nazoraios o Basileus ton Ioudaion* (typically abbreviated from the Latin version to "INRI" on crucifixes) (Dean, 2013). So it's unclear why basil's lumped in with royalty, but the story gets even more muddled when a mythical monster rears its tiny, ugly head. The basilisk, which you might remember from your Greek mythology or your Harry Potter, depending on your personal brand of nerdiness, was originally a tiny, highly venomous serpent. Roman naturalist Pliny the Elder named it *basiliskos*, Greek for "little king," because it supposedly had a crown-shaped mark on its head. It had the power to freeze living things with its gaze and melt surrounding shrubs with its poison, and might have been based on stories of King Cobras filtering over to Ancient Greece from India (Dean, 2013). Common sense might tell you that basil, a lovely little herb, has nothing in common with the basilisk, a nasty little snake, but herbologists of yore weren't famous for their common sense. Some said that it was a good cure for the basilisk's petrifying gaze, others that basil leaves, left alone under a pot for a while, would turn into a scorpion (an animal that was also associated with the basilisk), and a Frenchman named Hilarius said that just smelling basil would breed a scorpion in the brain, despite the notable lack of documented brain scorpion outbreaks (Dean, 2013). In French, the word for the monster and the herb are still the same (*basilic*), and Latin didn't bother to differentiate, either (both were *basiliscus*). Wacky historical quacks aside, it's hard to say whether the Romans used the same word for both because of a genuine connection or if it's more like the accidental case of "rocket" in modern English. Give it another couple

millennia, and etymologists of the future will be writing articles about the curious 20th-century association of arugula and spaceflight (Dean, 2013).

From its humble origins in the wilds of India, central Africa and Southeast Asia, *Ocimum basilicum* is one of the culinary world's most popular herbs, finding its way into dishes from every corner of the planet. With an incredible amount of variation, (over 150 different types of basil and counting!) from "Holy Basil" to "African Blue Basil" to "Thai Basil", this strong, fragrant, and often sweet tasting member of the mint family has held some surprisingly important roles in history. In fact its name is rife with meaning, as Basil comes from the Greek word *Basileus*, meaning "king" (Yaney-Keller, 2020). From its birthplace in India, the variety "Holy Basil" (also called *tulsi*) is considered an essential religious symbol and venerated plant, the earthly incarnation of the god *Tulsi/Vrinda*. It is the holiest of all plants in Hinduism and no Hindu household is considered complete without a *tulsi* plant growing in its courtyard, often in a special pot or masonry structure. Offerings of basil leaves are required for worship of the god *Vishnu* and his avatars and its use in Ayurvedic medicine for all manner of prevention and cure is trumped by no other plant (Yaney-Keller, 2020). In ancient Egypt, basil was believed to have been used in embalming and preserving mummies, and has been found in ancient tombs beneath the pyramids. Interestingly enough, it was also thought to ensure safe journey to the afterlife, a belief shared in Ancient Greece, where basil was also associated with poverty and misfortune. On the island of Crete, it was an emblem of the devil, and was paradoxically planted on window ledges to ward away evil. In the modern day Greek Orthodox church, it is sometimes found on alters, and sprigs of it are used to sprinkle holy water. African folklore stated that it helped ease the pain of scorpion stings – perhaps misreading this, a 16th century French doctor believed it cause scorpions to grow in the brain of anyone who smelled or ate it! (Yaney-Keller, 2020). Basil is sometimes known as "herbe royale" (royal herb) in French and was believed to have grown on the original cross of Christ (perhaps another reason for its "kingly" name-sake) and in Jewish folklore was thought to lend strength while fasting. It was thought by some Medieval doctors to be poisonous, and by others to cure the venom of the infamous Basilisk monster (also from Harry Potter fame), which could kill by simply gazing at its victims. Today in Portugal, it is considered a symbol of love, given to loved ones in a small decorative pot or *manjerico* on St. Anthony's and St. John's days (Yaney-Keller, 2020). Uses for basil range from Thai to Italian cuisine. This herb traveled along medieval trade routes and eventually found its way to North America, where it is commonly found on many plates and in gardens today. The colorful history of basil is a testament to its remarkable taste and incredible variety. It's why we are so excited to highlight it in our first virtual tasting! (Yaney-Keller, 2020).

The name "basil" comes from the Greek *basilikon*, meaning "royal (plant)," itself derived from *basileus*, meaning "king." This regal name is thought to have its origin in the belief that basil was used in the making of royal perfumes (Jarry, 2021). There are many varieties of basil in existence. Perhaps the best known is sweet basil, common to the Mediterranean region. A Thai variety has a spicy hint of licorice, while lemon and lime basil add a citrusy flavour to meals (Jarry, 2021). To unpack where all of basil's delicious aromas come from, we have to talk about secondary compounds. Plants require essential substances like water, nitrogen, and carbon dioxide in order to survive. But other substances—often products of the plant's metabolism—are not vital and they end up accumulating in plant tissues. These are known as secondary compounds. Some will attract pollinators, like bees, while others will repel predators by making the plant bitter to the taste or poisonous. The usefulness of these secondary compounds is not limited to the plants themselves; humans have also learned to put them to good (and sometimes less good) use. Salicylic acid gave us pain relief, caffeine made us more alert, and cocaine gave us Al Pacino's classic line, "Say hello to my little friend" (Jarry, 2021). There are many types of secondary compounds, one of them being the essential oils, these aromatic, oil-loving molecules that evaporate easily at room temperature and titillate our olfactory receptors. They are called "essential" not because they are vital to either the plant or us, but because they are said to contain the essence of the plant. The smell and taste we associate with basil come from a number of essential oil molecules that, depending on the species, the cultivar, and the growing conditions, will be present in different quantities in the leaves. Taking a peep at the main aromatic compounds found in basil is in itself a tasty lesson in chemistry (Jarry, 2021). Basil contains estragole, also known as methyl chavicol. Estragole is a relatively small carbon-based molecule used in perfumes, and it can be found not just in basil but in fennel, pine oil, and tarragon. In fact, the name "estragole" comes from the French name for tarragon, *estragon* (Jarry, 2021).

Sweet basil is an aromatic plant directly used for spice, medicine, feed of honeybee, ornamental and also used as raw material for different industries. Sweet basil is most widely cultivated due to its high economical value, popularity and demands among the economically important species of basil (Egata, 2021). Sweet basil is widely distributed throughout subtropic and tropical regions and currently widely cultivated in India, Ethiopia, Egypt, Iran, Japan, China and Turkey. Commercially, it extensively cultivated for essential oil production in many continents around the world for its numerous economical, medicinal and aromatic values (Egata, 2021). In Ethiopia, sweet basil is popular spice plant used by population and each Ethiopian ethnic groups have different names for sweet basil throughout the country (Egata, 2021). Ethiopian farmers conventionally cultivate and use this crop for house consumption and provide for local market mainly as spice. Sweet basil's aromatic leaf directly used as flavouring agent in different foods and beverages industries (Egata, 2021). Oil and oleoresin of sweet basil indirectly widely used for flavour and fragrance in the food, pharmaceutical, cosmetic, and aromatherapy industries. It also used extensively in pharmaceutical, cosmetics, aromatherapy and food industry (Egata, 2021). The other use of sweet basil is for production of honey and can be used as ornamental plant. Sweet basil is very important crop that can play great role on the economy of Ethiopian farmers (Egata, 2021). Generally, Sweet basil plant can be considered as; easily available, easy to grow, have multipurpose advantages that should be produced as high value crop (Egata, 2021). This plant widely grown in India, Brazil and several Mediterranean countries including Turkey as annual plant for its aromatic plant of decorative habit, leaves and flowers (Egata, 2021). It is also a highly valued melliferous or highly honey producing plant. The visiting and pollinating insects are mainly honeybees and solitary bees, as well as bumblebees (Egata, 2021).

Flowers of basil seem to be a good source of nectar for the honeybee because of high yield of sugars and long flowering period. Basil flowering starts in June and lasts up to September. The flowers are of different colors: from white in green-leaved cultivars, to pink violet in purple-leaved cultivars (Egata, 2021).

Basil still reigns today as the King of Herbs. Its royalty was established by the Greeks, when they gave the herb its name based on the Greek word *basilikon*, meaning “king.” Alexander the Great is said to have brought basil to the Greeks (Readal, 2022). According to legend, St. Helena, the Emperor Constantine’s mother, followed a trail of basil leading to the remains of Jesus’ cross. Since that time, basil has been considered a holy herb in Greece (Readal, 2022). Basil is used in the Greek Orthodox Church for sprinkling holy water, while some Greeks bring their basil to church to be blessed and then hang the sprigs in their home for health and prosperity. However, on the isle of Crete, basil somehow gained a bad reputation and was thought to be a symbol of the devil. There seems to be a thread of bad history associated with basil since early times (Readal, 2022). Although named by the Greeks, basil originated in India 5,000 years ago. In India today, the herb is considered a sacred herb. Holy basil, also known as tulsi, is considered to be the manifestation of the goddess Tulasi, wife of Krishna. It is thought to have great spiritual and healing powers (Readal, 2022). According to legend, only one leaf of tulsi can outweigh Vishnu’s power. Every devout Hindu home will have a special place for a tulsi plant. It is believed that the creator god, Brahma, resides in its stems and branches, the river Ganges flows through the plant’s roots, the deities live in its leaves, and the most sacred of Hindu religious texts are in the top of holy basil’s branches (Readal, 2022). Nurturing a tulsi plant ensures that a person’s sins will be forgiven and everlasting peace and joy will be had. The dried stems of old holy basil plants are used to make beads for Hindu meditation beads (Readal, 2022). Twentieth-century herbalist Maude Grieve said, “Every good Hindu goes to his rest with a basil leaf on his breast. This is his passport to heaven. It is indeed considered a powerful herb” (Readal, 2022). From India, basil spread to Egypt, where the herb was used for embalming and has been found buried with the pharaohs. The herb then moved on to Rome and southern Europe, where the Romans fell in love with it. In Italy, basil was considered a sign of love. If young girls were seeking a suitor, they would place a pot of basil on their windowsill. If a potential suitor showed up with a sprig of basil, the girl would love him forever (Readal, 2022).

In recent years, natural plant-based products have emerged as a valuable global resource for the development and innovation of novel drugs. Hence, exploring bioactive compounds from various sources, including plants, might be an excellent method for discovering new potential drugs. This is because the current availability of raw materials for drug discovery and development, pharmacophores, and a framework for effective medications for a wide range of clinical indications is notably limited. Hence, ethnopharmacological studies are of great significance, as they harness traditional knowledge to effectively screen and improve the chances of discovering novel drugs (Azizah *et al.*, 2023). Basil is one of the species in the Lamiaceae family, which is well known for having a wide variety of medicinal properties. The plant is traditionally recognized for its utilization for both culinary and perfumery purposes. For example, in the province of East Nusa Tenggara, Indonesia, the Tetun people frequently consume fresh, raw *O. basilicum* L. leaves in order to treat malaria. In addition, it is also used for treating rheumatism, high cholesterol, hypertension, headaches, and stroke in the Indonesian province of North Sumatra by the Batak Karo people. *O. basilicum* L. leaves also find application as an anti-helminthic remedy among the Muna Tribe in the province of Southeast Sulawesi, Indonesia (Azizah *et al.*, 2023).

The plant can grow up to 0.6 m in height, with lateral branches creating an angle of more than 30° with the main branch. The stem is round–quadrangular, glabrous (smooth, hairless), or puberulent (fine short hairs), concentrated on the two opposing faces of the stem (Figure 1A). Inflorescence is dense (Figure 1B), arranged around a point on 1C). The leaves are green, the apex mostly acute or acuminate; the shape is ovate or elliptic ovate; the size is about 15–50 × 5–25 mm; the leaf margin is entirely or sparsely serrate and with a glandular–punctate shape. The petiole is about 20 mm long and pubescent (covered with soft short hair) (Figure 1D). The corolla with a white or pinkish color tube—about 7–8 mm long—is funnel-shaped (Figure 1E). The calyx pilose (covered with soft long hair or pubescent) has a dense ring of hairs at the throat, and a fruiting calyx is about 6 mm long. The stamen has tufted hairs near the base. The nutlets are dark brown in color, with an elliptic shape, and they produce mucilage upon interaction with water (Azizah *et al.*, 2023).



Figure 1: (A) *O. basilicum* L. plant habit in a plantation area (B) Full *O. basilicum* L. inflorescence. (C) Separate photograph detailed section of inflorescence. (D) Leaf. (E) Flower

Basil's [Sweet Basil] origin is native to India. Some sources report that the word *basil* is linked with the Greek word for king (Basileus) while others say the plant is named after a fabled reptile, the *basilisk*, a beast that could kill a person by its breath or glance. In either case, basil is an unusual herb with mixed traditions, for example, it is considered symbolic of poverty and hatred throughout much of northern and central Europe, but highly revered and respected in southern Europe among Italians and Greeks. Throughout India today basil remains sacred to the Hindu gods Krishna and Vishnu. Modern Hindus place a leaf of basil on the breast of the dead prior to burial. In Jewish tradition basil leaves, worn individually or as a small garland, are said to add strength during fasting periods (NG, 2024). The Gerarde herbal suggests that basil dulls the sight, dries up mother's milk, and is hard on the digestion; when basil leaf juice is mixed with finely ground parched barley, oil of roses, and vinegar, it is good medicine against inflammations and the stings of poisonous beasts; juice of basil leaves mixed with wine from Chios is good for headache; the juice clears eyes of their dimness. Gerarde recommended basil seed beverages as a cure for those in a melancholy state and for others with labored breathing; basil leaves or seeds inserted into the nose cause sneezing [thus purging the brain]; basil leaves reduce the pain of scorpion bites; the smell of basil is good for the heart and brain, while basil seeds cure heart infirmities, take away sorrow that accompanies melancholia, and makes consumers merrier and glad (NG, 2024). Basil commonly is used in Christian cuisine throughout southern Europe. The link of basil with Christianity is seen in the presumed identification by Helena (mother of Constantine the Great), who reportedly found sprigs of basil growing next to the cross on which Christ was crucified. Basil commonly is associated with death and destruction. Throughout Iran and Malaysia basil is planted on graves while in Egypt Moslem women scatter leaves and flowers on the graves of family members. And in some traditions basil is the symbolic plant of Satan. Traditional Romanians in central Europe believe that if a man accepts a sprig of basil from a girl, she will become his wife. According to traditional Germanic-speaking peoples, a basil leaf serves as a test of purity: it is said that if a non-virgin touches a leaf of basil it will wither (NG, 2024). Basil is widely linked with scorpions. One tradition holds that applying basil leaves to scorpion bites will draw out the poison. Curiously, there are other old English traditions that if a sprig of basil is left under a pot inside or outside the house, the leaf will turn into a scorpion! This tradition also has been reported during recent centuries in Milan and Genoa, Italy, where it sometimes has been said that basil plants are homes for scorpions (NG, 2024). In some Medieval drawings the image of Poverty is depicted as an old woman dressed in rags seated or standing next to a basil plant. Yet other traditions suggest the contrary: in past centuries in England infusions of basil were prescribed and drunk to produce a cheerful/merry heart (NG, 2024).

Holy basil flowering plant of the mint family (Lamiaceae) grown for its aromatic leaves. Holy basil is native to the Indian subcontinent and grows throughout Southeast Asia. The plant is widely used in Ayurvedic and folk medicine, often as an herbal tea for a variety of ailments, and is considered sacred in Hinduism. It is also used as a culinary herb with a pungent flavor that intensifies with cooking. It is reminiscent of clove, Italian basil (*Ocimum basilicum*), and mint and has a peppery spiciness. It is considered an agricultural weed and an invasive species in some areas outside its native range (Petruzzello, 2024). The holy basil plant is revered in Hinduism as a manifestation of the goddess Lakshmi (Tulsi), the principal consort of the god Vishnu. The plant is especially sacred to Vaishnavites (devotees of Vishnu), and the Lord Krishna, an avatar of Vishnu, is said to wear a garland of holy basil leaves and flowers around his neck. The plant is grown in many Hindu homes, often in the courtyard in a dedicated four-sided structure, and the presence of a holy basil plant is believed to increase piety, foster meditation, purify, and protect. Devotees commonly worship in the morning and evening with mantras and offerings of flowers, incense, or water from the Ganges, and Tuesdays and Fridays are considered especially sacred (Petruzzello, 2024). Even the ritual act of watering and caring for the plant, usually undertaken by the women of the house, is considered worshipful and meritorious. Holy basil is cultivated at many temples, and the woody stems of plants that have died are used to make beads for sacred *japa mala* (rosaries). The beginning of the Hindu wedding season is marked by a festival known as Tulsi Vivah, in which homes and temples ceremonially wed holy basil to Vishnu. Water infused with the leaves is often given to the dying to help elevate their souls, and funeral pyres are commonly fitted with holy basil twigs with the hopes that the deceased may obtain *moksha* and be liberated from the cycle of rebirth (Petruzzello, 2024).

Basil an annual herb belonging to the mint family (Lamiaceae), boasts a rich history of use in both culinary and medicinal contexts over thousands of years (Bashyal, 2024). Originating in the tropical regions of Asia and Central and South Africa, the *Ocimum* genus comprises a wide spectrum of 50 to 150 species and varieties (Bashyal, 2024). Basil, recognized by various names globally, holds a significant role in diverse culinary traditions. It is known as sweet basil in English, babui tulsi in Hindi and Bengali, and by a range of names such as basilica, basilikum, rehan, and albahaca in different languages (Bashyal, 2024). Beyond being a culinary mainstay, basil is a focal point of botanical interest due to its extensive cultivar variations, with more than 160 named cultivars currently identified (Bashyal, 2024). The aromatic and flavorful characteristics of basil, spanning from cinnamon and liquorice to lemon and anise, contribute to its adaptability in cooking. The manifold uses of basil, ranging from culinary applications to enhancing ornamental landscapes, underscore its worldwide popularity and economic significance (Bashyal, 2024). Basil holds cultural significance, being considered a sacred herb in Hindu traditions. It is used in burial ceremonies in both India and Egypt (Bashyal, 2024). The name "basil" comes from the Greek word "basileus," meaning "king." It is also linked to the word "basilisk," a legendary dragon capable of slaying with a single glance (Bashyal, 2024). Romans believed that the fragrance of basil stimulated love. Women seeking true love would give a sprig of basil to their intended, while Italian men used it in courtship by wearing a sprig in their hair (Bashyal, 2024). In the Middle Ages, there was a belief that basil could create scorpions, showcasing the diverse historical perceptions of the herb (Bashyal, 2024). In the Victorian language of flowers, basil symbolizes both hatred (common basil) and best wishes (sweet basil), reflecting its polarizing associations (Bashyal, 2024).

In this review article on Origin, Taxonomy, Botanical Description, Genetic Diversity, Breeding and Cultivation of Basil are discussed.

ORIGIN AND DISTRIBUTION

Basil is native to areas in Asia and Africa and grows wild as a perennial on some Pacific islands. Basil was brought from India to Europe through the Middle East in the sixteenth century, and subsequently to America in the seventeenth century (Sullivan, 2009). Basil is one of the most important herbs to many cultures and cuisines, including Italian, Thai, Vietnamese, and Laotian. The basil variety *tulsi* is a sacred herb in the Hindu religion; indeed, while basil is used relatively sparsely in Indian cuisine, *tulsi* is considered holy. In Hindu houses, basil is the protecting spirit of the family. The British at one time used *tulsi* as a substitute for a Bible upon which the Indians would take an oath in a court of law (Sullivan, 2009). The scorpion is historically associated with basil, which is likely due to the potential derivation of the name from the Latin *basilisk*. It was advised to handle basil gently as to avoid the breeding of scorpions. Scorpions were believed to seek out basil pots to rest under, and superstition taught that a sprig of basil left on its own underneath a pot would eventually turn into a scorpion. Similarly, a sixteenth century Flemish doctor wrote of his belief that crushed basil left between bricks would turn into scorpions. Perhaps the most outlandish of the scorpion-related superstitions, as affirmed by the French doctor Hilarius, was that smelling basil would breed a scorpion in the brain. While considered of great significance throughout much of history and in many cultures, in the 1980s the British Ministry of Agriculture's bulletin on herbs stated basil to be „of little or no importance“. Hindus and most other modern consumers would likely disagree (Sullivan, 2009). Basil is widespread in Asia, Africa and central and Southern America. It appears to have its centre of diversity in Africa. There are more than 50 species of basil. These differ in growth habit, physiological appearance, and chemical and aromatic composition. Basil was probably first cultivated in India (AFF, 2012). Sweet basil or basil is a common name for the culinary herb *O. basilicum*. Basil is probably native to Asia and Africa, but is cultivated as a popular garden annual herb worldwide. It is thought to have been brought to ancient Greece by Alexander the Great (356–323 BCE.), to England from India in the mid-1500s, and to the United States in the early 1600s. The plant is produced commercially in many countries such as Egypt, India, Indonesia, Mexico, and the United States. In 1999, the United States imported 3574 tons of dried basil leaf (Li and Chang, 2016a). Basil is called by many names like sweet basil or even Thai basil, but all of its common names refer to the herb's botanical name, *Ocimum basilicum*. Basil is a member of the large mint family, or *Lamiaceae* family, along with other culinary herbs like rosemary, sage, and even lavender. It is believed that basil has origins in India, but the herb has been cultivated for over 5,000 with its reach spreading to all corners of the globe. There are some indications that basil may have originated even farther east than India with ancient records from 807 A.D. suggesting that sweet basil was used in the Hunan region of China at that time. Basil eventually migrated westward as whole plants as it could be grown easily indoors and away from exposure to cold climates and frost (Filippone, 2019).

TAXONOMY

The name basil is derived from the Greek word, *basileus*, which means “royal or king-like” because of the royal fragrance of this herb. Basil is commonly referred to the genus *Ocimum*. Accepted 66 of a total of 327 species of herbs and shrubs recorded in the genus *Ocimum*. There are many basil varieties, with new varieties being added every year. The taxonomy of basil has been greatly complicated by interspecific hybridization and polyploidy, as well as large morphological diversity and chemotype variation within basil species. Sweet basil or basil is a common name for the culinary herb *O. basilicum*. Basil plants can grow well indoors and outdoors under sunny and moist conditions. The plant is produced commercially in many countries such as Egypt, India, Indonesia, Mexico, and the United States. In 1999, the United States imported 3574 tons of dried basil leaf (Li and Chang, 2016a). *Ocimum* has over 150 species and is extensively cultivated in countries such as Indonesia, India, Morocco, France, Hungary, Greece, and Egypt. Although it is grown as a common garden herb, basil is most likely native to Asia and Africa (Azizah *et al.*, 2023).

The exact taxonomy of basil is uncertain due to the immense number of cultivars, its ready polymorphy, and frequent cross-pollination (resulting in new hybrids) with other members of the genus *Ocimum* and within the species. *Ocimum basilicum* has at least 60 varieties, which further complicates taxonomy (Wikipedia, 2024). *Ocimum* is a genus of aromatic annual and perennial herbs and shrubs in the family *Lamiaceae*, native to the tropical and warm temperate regions of all 6 inhabited continents, with the greatest number of species in Africa. It is the genus of basil and its best known species are the cooking herb great basil, *O. basilicum*, and the medicinal herb *tulsi* (holy basil), *O. tenuiflorum*. (Wikipedia, .2024).

As with many plants, the assignment of taxonomic systems to *Ocimum* species has been an active and contentious area. The genus was named by Swedish naturalist Carl Linnaeus in 1753 and enumerated into five species. In the past 250 years, there have been a number of taxonomic systems proposed, greatly expanding the species number of *Ocimum*. These systems were based on the structure of the plants, particularly those of the flower parts. The most recent system in common use is that of British plant taxonomist Alan Paton and his fellow researchers from 1999, in which *Ocimum basilicum* is placed within the *Ocimum* section of this genus. The morphology of the plants can vary greatly, however, given the crossbreeding between various cultivars and species. The science of chemistry was in its infancy when the original *Ocimum* taxonomic schemes were proposed. Since then, the advent of analytical chemistry has enabled the study of the numerous aromatic compounds found in all species of *Ocimum*, particularly those of the essential oils of these plants. This has enabled researchers to classify types of basil based on their chemical profile—a field called chemotyping. One problem with this avenue of research is that the particular chemicals in a given plant can vary widely depending on the environmental conditions, seasons, and soil and region in which the plant is grown (ECP, 2024). Other methods of taxonomic classification of basil include examining the geographic origin of the plants and whether or not they can be crossed with one another. With the discovery of DNA and cell nuclei, karyotyping became a viable method of analysis. This technique involves determining the number and appearance of chromosomes per cell in an organism. One problem with using this technique in basil is that researchers have found the chromosome count to vary widely within the same species

(ECP, 2024). The advent of molecular biological techniques, such as the polymerase chain reaction (PCR), have ushered in a new era in plant taxonomy. A class of techniques based on PCR amplification of small amounts of DNA takes advantage of minor changes in the structure of genes. This enables genetic fingerprinting to be performed in plants and gives a much more rigorous analysis of genetic relatedness. Croatian scientist Klaudija Carovic-Stanko and coworkers published such research in 2010 comparing 28 accessions of basil, including 22 of *Ocimum basilicum*. In addition to PCR techniques that had been previously used in studies of basil taxonomy, along with chromosome counting, they also examined nuclear DNA content (ECP, 2024). Of the two PCR methods used, AFLP (amplified fragment length polymorphism) was successful in separating all of the accessions from one another. The commonly used technique RAPD (random amplified polymorphic DNA) did not distinguish between all of the accessions. In tandem, both of these techniques enabled the researchers to successfully classify all of the plants tested (ECP, 2024). The current classification of basil includes several varieties and a very large number of cultivars. The primary variety of *Ocimum basilicum* in cultivation is *basilicum*, in particular cultivars Sweet Basil and Genovese. Also notable are varieties *purpurascens* Benth. (purple basil), and *difforme* Benth (ECP, 2024)

Species (Wikipedia, 2024).

- *Ocimum albostellatum* (Verdc.) A.J.Paton
- *Ocimum americanum* L. (tropical Africa), Indian subcontinent, China, southeast Asia
- *Ocimum amicum* A.J.Paton - Tanzania
- *Ocimum angustifolium* Benth. - southeastern Africa from Kenya to Transvaal
- *Ocimum basilicum* L. – (Basil, Sweet basil) - China, Indian subcontinent, southeast Asia
- *Ocimum burchellianum* Benth. - Cape Province of South Africa
- *Ocimum campechianum* Mill. – Amazonian basil - Florida, Mexico, West Indies, central and South America
- *Ocimum canescens* A.J.Paton - Tanzania
- *Ocimum carnosum* (Spreng.) Link & Otto ex Benth. - Mexico, South America
- *Ocimum centraliafricanum* R.E.Fr - Zaïre, Tanzania, Zambia, Zimbabwe
- *Ocimum circinatum* A.J.Paton - Ethiopia, Somalia
- *Ocimum coddii* (S.D.Williams & K.Balkwill) A.J.Paton - Northern Province of South Africa
- *Ocimum cufodontii* (Lanza) A.J.Paton - Ethiopia, Somalia, Kenya
- *Ocimum dambicola* A.J.Paton - Tanzania, Zambia
- *Ocimum decumbens* Gürke - from Zaïre to South Africa
- *Ocimum dhofarensis* (Sebald) A.J.Paton - Oman
- *Ocimum dolomiticola* A.J.Paton - Northern Province of South Africa
- *Ocimum ellenbeckii* Gürke - Ethiopia, Zaïre
- *Ocimum empetroides* (P.A.Duvign.) ined. - Zaïre
- *Ocimum ericoides* (P.A.Duvign. & Plancke) A.J.Paton - Zaïre
- *Ocimum filamentosum* Forssk. - eastern + southern Africa, Arabian Peninsula, India, Sri Lanka, Myanmar
- *Ocimum fimbriatum* Briq. - central Africa
- *Ocimum fischeri* Gürke - Kenya, Tanzania
- *Ocimum formosum* Gürke - Ethiopia
- *Ocimum forskolei* Benth. - eastern Africa from Egypt to Kenya, Angola, Arabian Peninsula
- *Ocimum fruticosum* (Ryding) A.J.Paton - Somalia
- *Ocimum grandiflorum* Lam. - Kenya, Tanzania, Ethiopia
- *Ocimum gratissimum* L. – African basil - Africa, Madagascar, southern Asia, Bismarck Archipelago
- *Ocimum hirsutissimum* (P.A.Duvign.) A.J.Paton - Zaïre
- *Ocimum irvinei* J.K.Morton - west Africa
- *Ocimum jamesii* Sebald - Ethiopia, Somalia
- *Ocimum kenyense* Ayob. ex A.J.Paton - Kenya, Tanzania
- *Ocimum kilimandscharicum* Baker ex Gürke – (Camphor basil) - Kenya, Tanzania, Uganda, Sudan, Ethiopia
- *Ocimum labiatum* (N.E.Br.) A.J.Paton - Mozambique, South Africa,
- *Ocimum lamiifolium* Hochst. ex Benth - eastern + central Africa
- *Ocimum masaiense* Ayob. ex A.J.Paton - Ngong Hills in Kenya
- *Ocimum mearnsii* (Ayob. ex Sebald) A.J.Paton - Kenya, Tanzania, Uganda
- *Ocimum metallorum* (P.A.Duvign.) A.J.Paton - Zaïre
- *Ocimum minutiflorum* (Sebald) A.J.Paton - eastern + central Africa
- *Ocimum mitwabense* (Ayob.) A.J.Paton - Zaïre
- *Ocimum monocotylodes* (Plancke ex Ayob.) A.J.Paton - Zaïre
- *Ocimum motjaneanum* McCallum & K.Balkwill - Eswatini
- *Ocimum natalense* Ayob. ex A.J.Paton - Mozambique, KwaZulu-Natal
- *Ocimum nudicaule* Benth. - Brazil, Paraguay, Argentina
- *Ocimum nummularia* (S.Moore) A.J.Paton - Somalia
- *Ocimum obovatum* E.Mey. ex Benth. - tropical Africa, Madagascar
- *Ocimum ovatum* Benth. - Brazil, Paraguay, Uruguay, Argentina

- *Ocimum pseudoserratum* (M.R.Ashby) A.J.Paton - Northern Province of South Africa
- *Ocimum pyramidatum* (A.J.Paton) A.J.Paton - Tanzania
- *Ocimum reclinatum* (S.D.Williams & M.Balkwill) A.J.Paton - Mozambique, KwaZulu-Natal
- *Ocimum sebrabergensis* Swanepoel & van Jaarsv.
- *Ocimum serpyllifolium* Forssk. - Somalia, Yemen, Saudi Arabia
- *Ocimum serratum* (Schltr.) A.J.Paton - South Africa, Eswatini
- *Ocimum spectabile* (Gürke) A.J.Paton - Ethiopia, Tanzania, Kenya, Somalia
- *Ocimum spicatum* Deflers - Ethiopia, Yemen, Kenya, Somalia
- *Ocimum tenuiflorum* L. – Holy basil, tulsi - China, Indian subcontinent, southeast Asia, New Guinea, Queensland
- *Ocimum transamazonicum* C.Pereira - Brazil
- *Ocimum tubiforme* (R.D.Good) A.J.Paton - Northern Province of South Africa
- *Ocimum urundense* Robyns & Lebrun - Burundi, Tanzania
- *Ocimum vandenbrandei* (P.A.Duvign. & Plancke ex Ayob.) A.J.Paton - Zaïre
- *Ocimum vanderystii* (De Wild.) A.W.Hill. - Zaïre, Congo, Angola, Zambia
- *Ocimum verticillifolium* Baker
- *Ocimum viphyense* A.J.Paton - Malawi, Zambia
- *Ocimum waterbergense* (S.D.Williams & K.Balkwill) A.J.Paton - Northern Province of South Africa
- *Ocimum* × *africanum* Lour. - Africa, Madagascar, China, Indian subcontinent, Indochina; naturalized in Guatemala, Chiapas, Netherlands Antilles, eastern Brazil
- *Ocimum* × *citriodorum* (*O. americanum* × *O. basilicum*) – Lemon basil
- *Ocimum kilimandscharicum* × *basilicum* 'Dark Opal' – African blue basil

Synonyms (IBP, 2024)

1. *Ocimum album* L.
2. *Ocimum anisatum* Benth.
3. *Ocimum barrelieri* Roth
4. *Ocimum basilicum purpurascens* Benth.
5. *Ocimum basilicum thyrsoiflorum* (L.) Benth.
6. *Ocimum basilicum* var. *album* (L.) Benth.
7. *Ocimum basilicum* var. *bullatum* (Lam.) Alef.
8. *Ocimum basilicum* var. *densiflorum* Benth.
9. *Ocimum basilicum* var. *difforme* Benth.
10. *Ocimum basilicum* var. *glabratum* Benth.
11. *Ocimum basilicum* var. *majus* Benth.
12. *Ocimum basilicum* var. *pelvifolium* Alef.
13. *Ocimum basilicum* var. *violaceum* Alef.
14. *Ocimum basilicum* var. *violocrispum* Alef.
15. *Ocimum basilicum* var. *viridicrispum* Alef.
16. *Ocimum basilicum* var. *vulgare* Alef.
17. *Ocimum bullatum* Lam.
18. *Ocimum caryophyllatum* Roxb.
19. *Ocimum chevalieri* Briq.
20. *Ocimum ciliare* B.Heyne ex Hook.f.
21. *Ocimum ciliatum* Hornem.
22. *Ocimum citrodorum* Blanco
23. *Ocimum cochleatum* Desf.
24. *Ocimum dentatum* Moench
25. *Ocimum hispidum* Lam.
26. *Ocimum integerrimum* Willd.
27. *Ocimum lanceolatum* Schumach. & Thonn.
28. *Ocimum laxum* Vahl ex Benth.
29. *Ocimum majus* Garsault, opus utique oppr.
30. *Ocimum medium* Mill.
31. *Ocimum minus* Garsault, opus utique oppr.

32. *Ocimum nigrum* Thouars ex Benth.
33. *Ocimum odorum* Salisb., nom. superfl.
34. *Ocimum scabrum* Wight ex Hook.f.
35. *Ocimum simile* N.E.Br.
36. *Ocimum thyrsoiflorum* L.
37. *Ocimum urticifolium* Benth., nom. inval.
38. *Plectranthus barrelieri* (Roth) Spreng.

BOTANICAL DESCRIPTION

Sweet basil (*Ocimum basilicum*) will grow to a size of 1-2 feet in height. Basil will prolifically produce large green leaves, measuring around 2 inches in length, throughout the summer. Basil flowers are white, and are commonly removed to increase yield of leaves. Cultivars of sweet basil include Lemon Basil, Italian or Curly Basil, and Lettuce-leaf Basil; the names of these cultivars give way to their variances. Bush basil (*Ocimum minimum* L.), is smaller in size and more compact than sweet basil. Bush basil grows to a height of around 10 inches with leaves of a maximum length of ½ inch. Its flavor is less vigorous than that of sweet basil and is grown primarily as a decorative plant. Basil has the ability to synthesize and convert phenylpropanes (important chemicals in determining the flavor of herbs which can also act as cultivator attractants or herbivore deterrents).

The flavor and smell of basil varieties is largely determined by their chemical components – basil varieties contain the following oils in varying quantities: cinnamate, citronellol, geraniol, linalool, methyl chavicol, myrcene, pinene, ocimene, terpineol (Sullivan, 2009). Basil is an erect herbaceous annual plant, or sometimes grown as a short-lived perennial in some areas. It grows in to a bushy shape up to about 50 cm tall and some varieties may even grow taller. The stems are herbaceous in young tissues, however, these become woody as the plant matures. The leaves are broad, oval shaped and 5 to 8 cm long. The leaves are yellowish-green to bright green or red coloured and larger or smaller, depending on the form and variety, and on the fertility of the soil. The texture of the leaves varies from silky and shiny to dull and crinkly. Variation is the result of the many cultivars in use. Small white to purple flowers appear in summer and are arranged in whorls on the ends of branches. The flowers produce seeds, which are oblong, ranging from brown to black in colour. The seeds self-sow readily and are easy to germinate as there is no dormancy requirement. Leaves, stems and flowering tops are used. Basil is primarily cultivated for its aromatic leaves, which are used fresh or are dried for essential oil distillation, or for use as flavouring (AFF, 2012). Basil is an herb that is most often used in Italian cuisine. It is also a popular herb in Asian dishes. Basil is part of the mint family. The plant has small, shiny green leaves and a very distinct aroma. Basil's flavor is sweet and pungent. There are two main varieties of basil: Sweet basil and Thai basil. Sweet basil is most often used in Italian cuisine and Thai basil in Asian cuisine. This herb is native to India and today there are over 150 varieties of basil (Myspicer, 2014).

Basil is an annual, or sometimes perennial, herb. Depending on the variety, plants can reach heights of between 30 and 150 centimetres. Basil leaves are glossy and ovulate, with smooth or slightly toothed edges that typically cup slightly; the leaves are arranged oppositely along the square stems. Leaves may be green or purple. Its flowers are small and white, and grow from a central inflorescence, or spike, that emerges from the central stem atop the plant. Unusual among Lamiaceae, the four stamens and the pistil are not pushed under the upper lip of the corolla, but lie over the inferior lip. After entomophilous pollination, the corolla falls off and four round achenes develop inside the bilabiate calyx (Wikipedia, 2024). Basil also known as French Basil or Sweet Basil or Tulsi is an erect glabrous herb, 30-90 cm high is indigenous to India. The leaves of basil have numerous oil glands with aromatic volatile oil. The herb bears cluster of small white lipped flowers in racemes. The freshly picked bright green leaves turns brownish green when dried and become brittle and curled. The major types are American Basil, French Basil, Egyptian Basil and Indian Basil (SBI, 2024). The holy basil plant is a small annual or short-lived perennial shrub, up to 1 meter in height. The stems are hairy and bear simple toothed or entire leaves oppositely along the stem.

The fragrant leaves are green or purple, depending on the variety. The small purple or white tubular flowers have green or purple sepals and are borne in terminal spikes. The fruits are nutlets and produce numerous seeds (Petruzzello, 2024). Basil leaves are glossy and oval-shaped, with smooth or slightly toothed edges that typically cup slightly; the leaves are arranged oppositely along the square stems. The small flowers are borne in terminal clusters and range in colour from white to magenta. The plant is extremely frost-sensitive and grows best in warm climates (Petruzzello, 2024). Basil, *Ocimum basilicum*, is a short lived annual or perennial plant in the family Lamiaceae grown for its leaves which are used as a herb. The basil plant grows from a thick taproot and has silky green opposite (paired) oval leaves which grow to be 3–11 cm long and 1–6 cm, branching out from the central stem. The plant produces small white flowers which are clustered on a single spike at the top of the plant. Basil plants are often grown as annuals but may survive for several seasons with some care and can reach heights between 30 and 130 cm depending on the variety. Basil may also be referred to as sweet basil, St. Joseph's wort, thai basil, lemon basil or holy basil depending on the variety and is native to India and other tropical regions of Asia (Plantvillage, 2024). Common types of basil are given in Table 1.

Table 1. These are some of the more common types (Rindels, 1997)

Common Name	Latin Name	Description
Sweet Basil	<i>Ocimum basilicum</i>	Most common type grown. White flowers. Bright green, 2 to 3 inch long leaves. Erect habit. Clovelike scent.
'Genovese' Basil	<i>Ocimum basilicum</i> 'Genovese'	An Italian strain, regarded as the best variety for pesto and garlic dishes. Dark green leaves up to 2 inches long. Slow to bolt. Erect habit.
Bush or Greek Basil	<i>Ocimum basilicum minimum</i>	Dwarf varieties with very small, less than 1/2 inch long, pungent leaves. White flowers. Plants are excellent for edging or containers. Flavor is preferred by many chefs. Varieties like 'Fine Green,' 'Green Bouquet,' and 'Spicy Globe' are widely available.
Purple Basil	<i>Ocimum basilicum</i> 'Purpurascens'	Grown for their ornamental foliage as well as their 'culinary uses. Soft lavender flowers. Same shape and size leaf as sweet basil. 'Opal,' 'Purple Ruffles,' and 'Red Rubin' are excellent selections.
Lettuce-leaf Basil	<i>Ocimum basilicum crispum</i>	Large, wide leaves. Flavor is less pronounced than other green basil, sometimes preferred for salads or sauces. Common varieties include 'Mammoth,' 'Napoletano,' and 'Green Ruffles.'
Scented Basil	<i>Ocimum basilicum odoratum</i>	These basil possess flavors reminiscent of other plants. Cinnamon, lemon, and licorice or anise basil all fit in this category. They can be used in recipes where a touch of a different flavor is desired. Often used in fruit preserves or in custards and sorbets.
Holy Basil	<i>Ocimum canum</i> or <i>Ocimum sanctum</i>	Leaves are small and fuzzy with a sweet, clove-like fragrance. Violet or white flowers. Used in some religious ceremonies. Not highly suited for culinary uses.
Camphor Basil	<i>Ocimum kilimandscharicum</i>	Has a strong, medicinal scent. Gray-green foliage. Not used for culinary purposes.
Peruvian Basil	<i>Ocimum micranthemum</i>	Has a somewhat medicinal, sweet flavor though it can be used in cooking. Sparse flowering.
Thrysiflora Basil	<i>Ocimum thrysiflora</i>	Grown for its ornamental seed head. Forms a triangular shaped plant with a strong V shaped branching habit. The seed head is a mound of purple flowers.

Sweet basil or *tulsi* is a low-growing herb that is grown in warm, tropical climates. It is native to India and other tropical regions of Asia, where it has been cultivated for more than 5,000 years. Basil grows to between 30-60 centimeters (cm) tall, with opposite, light green, silky, flat, shiny leaves 3–7 cm long and 1–3 cm broad. The flowers are large, white in color, and arranged in a terminal spike. Unusual among Lamiaceae, the four stamens and the pistil are not pushed under the upper lip of the corolla, but lay over the inferior. After entomophilous (insect) pollination, the corolla falls off and four round achenes develop inside the bilabiate calyx (NWE, 2024). Sweet basil tastes somewhat like anise, with a strong, pungent, sweet smell. Basil is very sensitive to cold, with best growth in hot, dry conditions.

While most common varieties are treated as annuals, some are perennial, including African Blue and Holy Thai basil (NWE, 2024). Lemon basil (*Ocimum × citriodorum*), a hybrid between basil and African basil (*Ocimum americanum*), has a strong lemony smell and flavor very different from those of other varieties because it contains a chemical called citral (NWE, 2024). The word *basil* comes from the Greek βασιλεύς (*basileus*), meaning "king." Legend has it that it grew above the spot where St. Constantine and Helen discovered the Holy Cross. The Oxford English Dictionary quotes speculations that basil may have been used in "some royal unguent, bath, or medicine.

"Basil is still considered the "king of herbs" by many cookery authors. An alternative etymology has "basil" coming from the Latin word *basilicus*, meaning dragon and being the root for basilisk (legendary, venomous reptile), but this likely was a linguistic reworking of the word as brought from Greece (NWE, 2024). Basil is an upright and branching herb that typically reaches a height of 0.6 to 0.9 meters. The stems and branches are characterized by a square shape, and they are glabrous, meaning they are hairless. The color of the stems and branches can vary, ranging from green to occasional purple. The leaves of basil are simple and oppositely arranged along the stem. They are ovate in shape, featuring an acute tip and measuring between 2.5 to 5 cm or more in length. The leaf margins are generally entire, although they may occasionally be toothed or lobed. Basil leaves have numerous oil glands that release a strongly scented volatile oil. The inflorescence of basil typically takes on a racemose structure, with the terminal raceme notably longer than lateral ones. The bracts are stalked, ovate, and acute, and they are shorter than the calyx. The reproductive structures, the calyx, which is 5 mm long, enlarges on the fruit. The corolla, measuring 8–13 mm, can be white, pink, or purplish in color and may be glabrous or slightly pubescent. The fruit has a short pedicel, and the nutlets (seeds) are about 2 mm long, ellipsoid, black, and pitted (Bashyal, 2024).

Basil is an annual, or sometimes perennial, herb. Depending on the variety, plants can reach heights of between 30 and 150 centimetres. Basil leaves are glossy and ovulate, with smooth or slightly toothed edges that typically cup slightly; the leaves are arranged oppositely along the square stems. Leaves may be green or purple. Its flowers are small and white, and grow from a central inflorescence, or spike, that emerges from the central stem atop the plant. Unusual among Lamiaceae, the four stamens and the pistil are not pushed under the upper lip of the corolla, but lie over the inferior lip. After entomophilous pollination, the corolla falls off and four round achenes develop inside the bilabiate calyx (Inaturalist, 2024). It is an erect, herbaceous, much-branched softly hairy, biennial or triennial plant, 30-75 cm high. The leaves are elliptic-oblong, acute or obtuse, entire or serrate, pubescent on both sides, minutely gland dotted. The flowers are purplish or crimson, in racemes, close-whorled. The nutlets are subglobose or broadly ellipsoid, slightly compressed, nearly smooth, pale-brown or reddish with small, black markings (Eagri, 2024). Botanical description and Leaf, Flower and Seeds are given in Fig. 2 & 3.

		
<p>Basil seedlings</p>	<p>Young basil plants</p>	<p>Basil plants</p>

Continue....

		
<p>Basil flowers</p>	<p>Basil flowers</p>	<p>Basil leaves</p>
		
<p>Purple plant</p>	<p>The flowers and inflorescence of holy basil tenuiflor (<i>Ocimum um</i>).</p>	<p><i>Ocimum basilicum</i>- Field View</p>
		
<p><i>Ocimum basilicum</i> -Field View</p>	<p>Some nutlets enlarged</p>	

Fig.2. Botanical Description



Figure 3. Leaves, Flowers and Seeds

Flowers: Basil flowers contain both male and female parts and are irritatingly self fertile. The best way to cross breed is to let both strains flower and then select the recipient strain and keep it under a cloche or similar. Cut the flower spikes so that only a few flowers remain (maybe 20 or so actual flowers 3–5 on each spike) and then cut the anthers out of the flowers before they (the anthers) ripen. Then use a paintbrush to transfer pollen from the donor plant to the stigma of the recipient. With anything like luck, the seeds will be a cross between your desired strains (Matthews, 2024).

GENETICS AND CYTOGENETICS

Chromosome data obtained in our research could indicate that the basic chromosome number for species belonging to section *Ocimum* is $x = 12$. This suggestion implies that species belonging to *O. basilicum* clade are tetraploids, while species belonging to *O. americanum* clade are hexaploids. It seems that the basic chromosome number for *O. gratissimum* could be $x = 10$ and for *O. tenuiflorum* $x = 9$. The differences in genome size and chromosome number among *Ocimum* species indicate that evolution of their genomes was accompanied by both sequence deletion/amplification and chromosome rearrangements and polyploidization (Carović-Stanko *et al.*, 2010). Reports of cytogenetic studies have shown that polyploidy and chromosome number variations are common among *Ocimum* species. However, two basic chromosome numbers ($x = 8$ and $x = 12$) have been reported, on the basis of which the various species of the genus have been classified into two groups: *basilicum* group ($x = 12$) and *sanctum* group ($x = 8$). This cytogenetic variability presents a veritable resource to geneticists and plant breeders to develop plant varieties well adapted to specific agro-ecological zones in response to the ever increasing demand for this all-important plant species. From this work, it has been established that the population of *Ocimum basilicum* growing in the South-eastern region of Nigeria are characterized by polyploidy and chromosome number variation, with at least two cytotypes. The chromosome count of $2n = 60$ is a new number discovered in this study for this species. The plant species has asymmetrical karyotype with a higher proportion of acrocentric chromosomes, as compared to other forms of chromosomes, indicative of advancement in its evolutionary trend (Edet and Aikpokpodion, 2014). Among the different species, Basil (*Ocimum basilicum* L.), commonly known as sweet basil, is an annual aromatic and medicinal herb belonging to the Lamiaceae family. Sweet basil is an outcrossing tetraploid ($2n = 4 \times = 48$) species (Gossa *et al.*, 2024).

GENETIC DIVERSITY

Essential oil compositions of fresh and freeze-dried leaves were determined for 16 accessions of *Ocimum basilicum* belonging to different varieties to see whether they could be used as infraspecific taxonomic characters. One accession of *O. x citriodorum* was also studied. Some 30 monoterpenoids, sesquiterpenoids and phenylpropanoids were identified, the major components (more than 20% of the total essential oil composition in one or more accessions) being geraniol and neral in *O. x citriodorum*, and linalool, methyl chavicol, eugenol, methyl eugenol and geraniol in *O. basilicum*. Based on a combination of the latter compounds, five major essential oil profiles could be distinguished in the accessions studied for *O. basilicum*. These profiles were largely the same for fresh and freeze-dried material of the same plant, although in dried leaves, methyl chavicol and eugenol concentrations had generally declined in comparison to those of linalool. There appeared to be little correlation between essential oil patterns and varietal classification within *O. basilicum*. In view of the chemical heterogeneity of *O. basilicum* and its use as an essential oil-producing crop, culinary herb, medicinal plant and insect-controlling agent, in all of which chemicals play an important role, the infraspecific classification of this taxon should take chemical characters into consideration. A system for the classification of essential oil chemotypes in *O. basilicum* is proposed (Grayer *et al.*, 1996). The genus *Ocimum*, Lamiaceae, collectively called basil, has long been acclaimed for its diversity. *Ocimum* comprises more than 30 species of herbs and shrubs from the tropical and subtropical regions of Asia, Africa, and Central and South America, but the main center of diversity appears to be Africa (Simon *et al.*, 1999). It is a source of essential oils and aroma compounds, a culinary herb, and an attractive, fragrant ornamental. The seeds contain edible oils and a drying oil similar to linseed. Extracts of the plant are used in traditional medicines, and have been shown to contain biologically active constituents that are insecticidal, nematocidal, fungistatic, or antimicrobial (Simon *et al.*, 1999).

Most commercial basil cultivars available in the market belong to the species *O. basilicum*. It was classified in to seven cultivars types (Simon *et al.*, 1999):

- Tall slender types, which include the sweet basil group;
- Large-leafed, robust types, including 'Lettuce Leaf' also called 'Italian' basil;
- Dwarf types, which are short and small leafed, such as 'Bush' basil;
- Compact types, also described, *O. Basilicum* var. *thyrsiflora*, commonly called 'Thai' basil;

- *Purpurascens*, the purple-colored basil types with traditional sweet basil flavor;
- Purple types such as 'Dark Opal', a possible hybrid between *O. basilicum* and *O. forskolei*, which has lobed-leaves, with a sweet basil plus clove-like aroma; and
- *Citriodorum* types, which includes lemon-flavored basils.

Abuhashem *et al.*, (2023) investigated the morphological and genetic diversity of 25 basil landraces collected from 12 different geographical locations in Egypt. The results showed considerable variability in the morphological traits among the collected landraces, indicating the presence of numerous subtypes within the *Ocimum* sp. The productivity and biochemical parameters were also evaluated, revealing significant differences among the landraces. This comprehensive analysis of basil landraces encompassed the exploration of morphological traits, pairwise correlations, clustering analysis, and genetic diversity using SCoT markers. The study revealed significant correlations between traits, providing valuable insights for basil production and breeding programs. The clustering analysis identified distinct groups of landraces with shared characteristics, enabling targeted breeding efforts. Furthermore, the genetic diversity analysis using SCoT markers highlighted the presence of two distinct clades and subclades, offering insights into the genetic relationships between different basil accessions. Despite differences between the morphological and genetic trees, certain landraces demonstrated correlations, suggesting a convergence of traits. In Ethiopia, basil is the most widely used aromatic and medicinal herb. Despite being widely available across the nation and utilized for a variety of purposes for centuries, little is known about the degree of genetic variability in sweet basil. Thus, 62 basil accessions that were collected from various locations in Ethiopia were examined for genetic diversity and population structure, and genome-wide SNPs were created using genotyping by sequencing (GBS). The observed and expected heterozygosity are (0.01–0.02) and (0.13–0.33), respectively. The gene diversity index (GD) ranged from 0.13 to 0.29, with an overall mean of 0.13. Moreover, the polymorphic information content (PIC) varied from 0.23 to 0.37, with an average of 0.37. The Shannon index (I) ranged from 0.01 to 0.41, with an average of 0.12. A total variation of 90 % and 1 % within and among populations, respectively, was revealed using analysis of molecular variance (AMOVA). Furthermore, genetic variation showed a coefficient of gene differentiation of 0.01 and a gene flow value of 2.013 among populations. The 62 basil accessions were divided into two genetic groups according to STRUCTURE analysis, unweighted pair group method (UPGMA), discriminant analysis of principal components (DAPC), and principal coordinate analysis (PCoA). This research confirmed the diversity and population structure of the Ethiopian basil. Therefore, the variation pattern in their genetic diversity can serve as a basis for the selection, breeding, and maintenance of basil in Ethiopia (Gossa *et al.*, 2024)

BREEDING

Breeding: The species *Ocimum basilicum* originates in Asia and is now widely spread throughout the globe. In Europe, it is assumed that it was introduced in 356-323 BC by Alexandru Macedon. Although the plant has been present in the crop for a very long time, it is grown on very small areas in the household system. In Romania, very few researches have been carried out that have targeted this species, although in the world, the plant is cultivated and widely used in food as well as decorative, ornamental, medicinal, aromatic, melliferous plant. But in our country, it has been used mainly in the cult of the church as sacred plant. At V.R.D.S. Buzau research was started for breeding this species in 1996, because at that time there was no registered autochthonous variety in the Official Catalog of Crop Plants in Romania, the only commercial variety being a local "de Radovanu" population. In 2006, the researches on this species ended with the first Romanian basil variety registered in the Official Catalog of Crop Plants under the name of 'Aromat de Buzau'. Key words: 'Aromat de Buzau', Macedon, germplasm, genotype, variety (Vinătoru *et al.*, 2019).

Cultivars (Filippone, 2019).

- Anise basil, Licorice basil, or Persian basil (*O. basilicum* 'Liquorice')
- Cinnamon basil (*Ocimum basilicum* 'Cinnamon')
- Dark opal basil (*Ocimum basilicum* 'Dark Opal')
- Genovese basil or Sweet Basil (*Ocimum basilicum*)
- Greek basil (*Ocimum basilicum* var. *minimum*)
- Globe basil, dwarf basil, French basil (*Ocimum basilicum* 'Minimum')^[18]
- Lettuce leaf basil (*Ocimum basilicum* 'Crispum')
- Napolitano basil, also known as Napoletano basil, Neapolitan basil, Mammoth basil, Bolloso Napoletano basil, Napolitano Mammoth-Leafed basil, or Italian Large-Leaf basil (*Ocimum basilicum*)
- Purple basil (*Ocimum basilicum* 'Purpurescens')
- Rubin basil (*Ocimum basilicum* 'Rubin')
- Thai basil (*Ocimum basilicum* *thyrsofolium*)
- African blue basil (*Ocimum basilicum* × *O. kilimandscharicum*)
- Lemon basil (*Ocimum basilicum* × *O. americanum*)^{[19][20]}
- Spice basil (*Ocimum basilicum* × *O. americanum*), which is sometimes sold as holy basil.

With its wide culinary reach, different varieties of the basil plant have been adopted into the cuisines of different cultures. The flavors of sweet basil are all too familiar to Italian dishes where it is used liberally, whereas Thai basil (*O. basilicum* var. *thyrsoflora*), lemon basil (*O. X citriodorum*), and holy basil (*Ocimum tenuiflorum*) have become a staple in many Asian cuisines (Filippone, 2019). In India, two types of *O. sanctum* are under cultivation: the green type (Sri Tulsi) is the most common, the second type (Krishna Tulsi) bears purple leaves and is preferred in the trade for its higher potency of the drug (Eagri, 2024).

Most basil varieties are cultivars of sweet basil. Most basil varieties have green leaves, but a few are purple, such as, 'Purple Delight' (Inaturalist, 2024):

- Anise basil, Licorice basil, or Persian basil (*O. basilicum* 'Liquorice')
- Cinnamon basil (*Ocimum basilicum* 'Cinnamon')
- Dark opal basil (*Ocimum basilicum* 'Dark Opal')
- Genovese basil or Sweet Basil (*Ocimum basilicum*)
- Greek basil (*Ocimum basilicum* var. *minimum*)
- Globe basil, dwarf basil, French basil (*Ocimum basilicum* 'Minimum')^[18]
- Lettuce leaf basil (*Ocimum basilicum* 'Crispum')
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- Purple basil (*Ocimum basilicum* 'Purpurescens')
- Rubin basil (*Ocimum basilicum* 'Rubin')
- Thai basil (*Ocimum basilicum* *thyrsifolium*)
- African blue basil (*Ocimum basilicum* × *O. kilimandscharicum*)
- Lemon basil (*Ocimum basilicum* × *O. americanum*)^{[19][20]}
- Spice basil (*Ocimum basilicum* × *O. americanum*), which is sometimes sold as holy basil

The following are some of the common basil varieties (Plantvillage, 2024):

Thai basil: It is commonly used in Thai and Southeast Asian cuisine and adds a sweet licorice flavor to a dish)

Lemon basil: It has small leaves with a tangy lemon flavor.

Cinnamon basil: It is native to Mexico and adds a hint of cinnamon to a dish (typically paired with legumes or spicy stir-fried vegetables).

Sweet basil: It is commonly found in Italian dishes and is very popular. It has a unique taste that is similar to licorice and clove.

Basil cultivars are cultivated varieties of basil. They are used in a variety of ways: as culinary herbs, landscape plants, healing herbs, teas, and worship implements. All true basil varieties are species of the genus *Ocimum*. The genus is particularly diverse, and includes annuals, non-woody perennials and shrubs native to Africa and other tropical and subtropical regions of the Old and New World. Although it is estimated that there are 50 to 150 species of basil, most, but not all, culinary basil varieties are cultivars of *O. basilicum*, or sweet basil. Some are cultivars of other basil species, and others are hybrids.

Table 2. *Ocimum basilicum* cultivars

Common name	Species and cultivars
Sweet basil, Genovese basil, great basil	<i>O. basilicum</i>
Lettuce leaf basil	<i>O. basilicum</i> 'Lettuce Leaf'
Mammoth basil	<i>O. basilicum</i> 'Mammoth'
Genovese basil	<i>O. basilicum</i> 'Genovese Gigante'
Nufar basil	<i>O. basilicum</i> 'Nufar F1'
Spicy globe basil	<i>O. basilicum</i> 'Spicy Globe'
Greek Yevani basil	<i>O. basilicum</i> 'Greek Yevani'
Fino verde basil	<i>O. basilicum</i> <i>piccolo</i>
Boxwood basil	<i>O. basilicum</i> 'Boxwood'
Purple ruffles basil	<i>O. basilicum</i> 'Purple Ruffles'
Magical Michael	<i>O. basilicum</i> 'Magical Michael'
Dark opal basil	<i>O. basilicum</i> 'Purpurascens'
Red rubin basil	<i>O. basilicum</i> 'Purpurascens' 'Red Rubin'
Osmin purple basil	<i>O. basilicum</i> 'Osmin Purple'
Cuban basil	<i>O. basilicum</i>
Thai basil	<i>O. basilicum</i> var. <i>thyrsiflorum</i>
'Siam Queen'	<i>O. basilicum</i> var. <i>thyrsiflorum</i> 'Siam Queen'
Cinnamon basil	<i>O. basilicum</i> 'Cinnamon'
Licorice basil	<i>O. basilicum</i> 'Licorice'
White basil	<i>O. basilicum</i> var. <i>Pilosum</i>

It is particularly challenging to determine which species a basil belongs to. This is because basil cross-breeds easily, and drawing boundaries between species is particularly difficult. In fact, recent studies have led to reclassification of some portions of the genus. Basil cultivars vary in several ways.

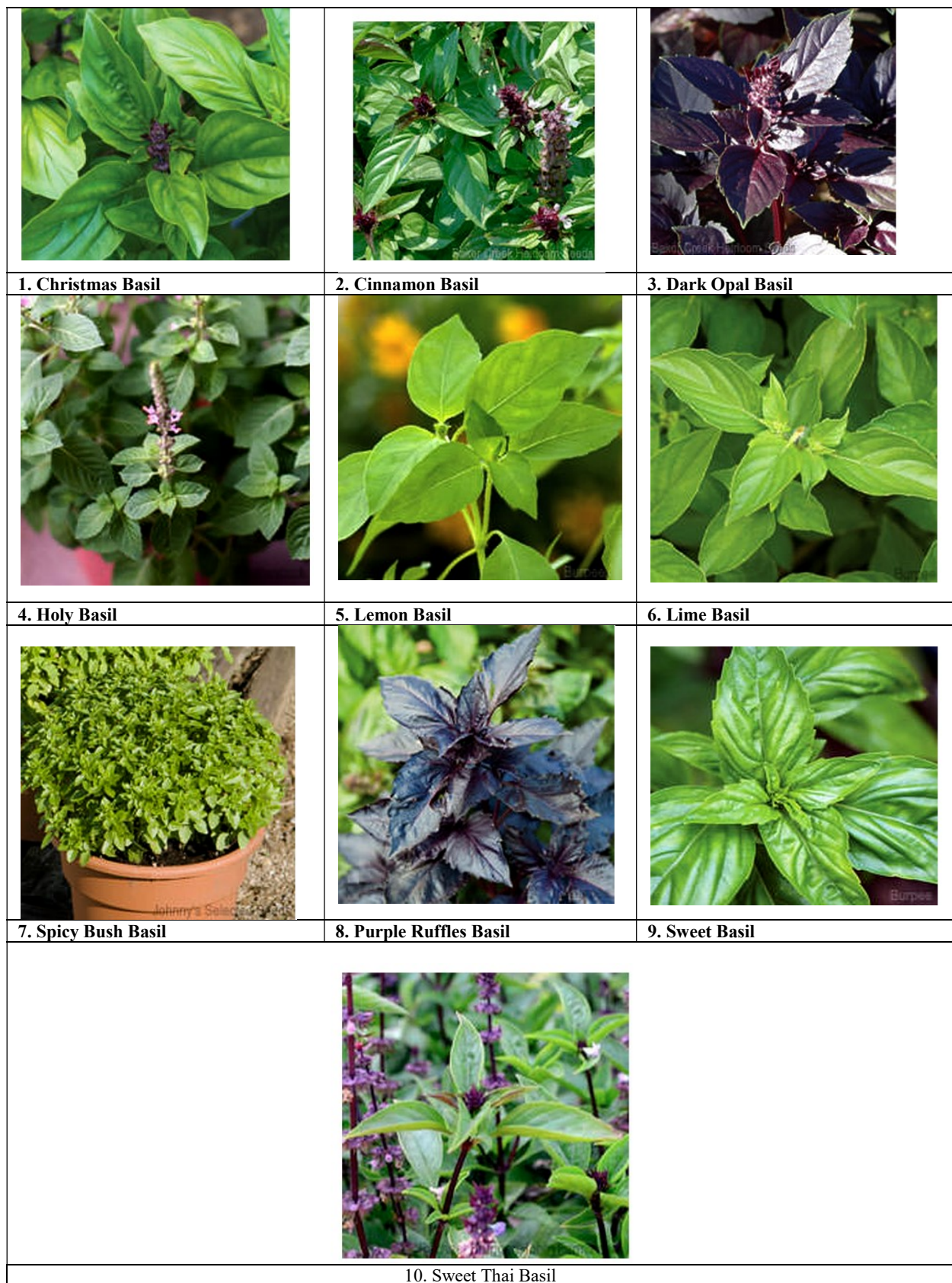


Figure 4. Basil Varieties (Source: Lehnhardt, 2024)

Visually, the size and shape of the leaves varies greatly, from the large lettuce-like leaves of the Mammoth basil and Lettuce leaf basil to the tiny leaves of the Dwarf bush basil. More practically, the fragrance of the basil varies due to the varying types and quantities of essential oils contained in the plants. The most important are cineol, linalool, citral, methyl chavicol (estragole), eugenol and methyl cinnamate, although hardly any basil contains all of these in any significant amount (Table 2) (Wikipedia, 2024).

Culinary uses: Sweet basil leaves may be consumed fresh or dehydrated, and the essential oil may be used for flavoring or medicinally. Dried basil, which may be purchased in the spice section of supermarkets, differs in flavor and aroma from the fresh herb, but can be stored much longer—up to six months in a cool, dark place in an airtight container. The fresh leaves may be refrigerated, wrapped in a barely damp paper towel in a plastic bag, for up to four days, or stored for up to a week as a bunch, with stems down, in a plastic-bag-covered container of water, if the water is changed every two days. The fresh herb can be kept for a longer period in the freezer, after being blanched quickly in boiling water (NWE, 2024). For consumption, sweet basil is most commonly recommended to be used fresh. In cooked recipes, it is generally added at the last moment, as cooking quickly destroys the flavor. The dried herb loses most of its flavor, and what little flavor remains tastes very different, with a weak coumarin flavor, like hay (NWE, 2024). Sweet basil is prominently featured in varied cuisines throughout the world including Italian, Thai, Vietnamese and Laotian. It is a key herb in Mediterranean cuisine (Herbst 2001).

Basic is a popular culinary herb used in many cuisines including Italian and Thai. It is used both fresh and dried, however the predominant flavors diminish with drying. The uses of basil are varied and plentiful; it is used with vegetables, meat, fish, sauces, stews, dressings, herbal teas, liqueurs, and mixed drinks. It is a traditional herb used in the preparation of turtle soup by the English. It is commonly used, both by the household and the industrial producer, in the preparation of pesto, a varying combination of basil, oil, garlic, cheese, and nuts. Frequently, basil is used as a complimentary flavor to tomatoes. Fresh basil is preserved in oil or vinegar, or frozen. Freezing basil preserves the flavor of the herb more effectively than does drying. The storage length of dried basil far exceeds that of fresh basil, which can be successfully stored in the refrigerator for a short time. Basil is best dried out of direct sunlight, which can brown the leaves in the drying process (Sullivan, 2009).

In Italian cuisine, basil adds wonderful flavor to tomato sauce, pesto, and vinegars. It can also be sprinkled over salads and sliced tomatoes. In Asian cuisine, this herb is great on salads and on many types of meat and vegetable dishes. It is also great in pesto (Myspicer, 2014). Basil continues to have diverse applications in modern kitchens and science labs. In cooking, basil is most commonly used fresh in cooked recipes. More often than not, the fresh leaves are added at the last moment, as cooking quickly destroys the herb's distinct flavor. But today as also seen throughout history, basil is not only used as a food flavoring, but also in perfumery, incense, and herbal holistic remedies. Recent scientific studies have established that compounds the essential oil of basil plants possess potent antioxidant, antiviral, and antimicrobial properties (Filippone, 2019). Basil is most commonly used fresh in recipes. In general, it is added last, as cooking quickly destroys the flavor. The fresh herb can be kept for a short time in plastic bags in the refrigerator, or for a longer period in the freezer, after being blanched quickly in boiling water. The most commonly used Mediterranean basil cultivars are "Genovese", "Purple Ruffles", "Mammoth", "Cinnamon", "Lemon", "Globe", and "African Blue". Basil is one of the main ingredients in pesto, an Italian sauce with olive oil and basil as its primary ingredients. Many national cuisines use fresh or dried basil in soups and other foods, such as to thicken soups. Basil is commonly steeped in cream or milk to create flavor in ice cream or chocolate truffles. Lemon basil has a strong lemony smell and flavor due to the presence of citral. It is widely used in Indonesia, where it is called *kemangi* and served raw as an accompaniment to meat or fish. When soaked in water, the seeds of several basil varieties become gelatinous, and are used in Asian drinks and desserts such as the Indian *faluda*, the Iranian *sharbat-e-rihan*, or *hôt é*. In Kashmir, the Ramadan fast is often broken with *babre beole*, a sharbat made with basil seeds (Wikipedia, 2024).

Basil is most commonly used fresh in recipes. In general, it is added last, as cooking quickly destroys the flavor. The fresh herb can be kept for a short time in plastic bags in the refrigerator, or for a longer period in the freezer, after being blanched quickly in boiling water. The most commonly used Mediterranean basil cultivars are "Genovese", "Purple Ruffles", "Mammoth", "Cinnamon", "Lemon", "Globe", and "African Blue". Basil is one of the main ingredients in pesto, an Italian sauce with olive oil and basil as its primary ingredients. Many national cuisines use fresh or dried basil in soups and other foods, such as to thicken soups. Basil is commonly steeped in cream or milk to create flavor in ice cream or chocolate truffles. Lemon basil has a strong lemony smell and flavor due to the presence of citral. It is widely used in Indonesia, where it is called *kemangi* and served raw as an accompaniment to meat or fish. When soaked in water, the seeds of several basil varieties become gelatinous, and are used in Asian drinks and desserts such as the Indian *faluda*, the Iranian *sharbat-e-rihan*, or *hôt é*. In Kashmir, the Ramadan fast is often broken with *babre beole*, a sharbat made with basil seeds (Inaturalist, 2024). The dried leaves and tender four sided stems are used as spice for flavouring and for extraction of essential oil. Apart from flavouring numerous foods, it is used for seasoning in tomato paste products. The sweet basil oil is widely used in perfumery compounds. It has application in areas of medicine and also used as an insecticide and bactericide (SBI, 2024). Basil is one of the main ingredients in pesto—a green Italian oil-and-herb sauce from the city of Genoa, its other two main ingredients being olive oil and pine nuts. The most commonly used Mediterranean basil cultivars are "Genovese," "Purple Ruffles," "Mammoth," "Cinnamon," "Lemon," "Globe," and "African Blue." Chinese also use fresh or dried basil in soups and other foods. In Taiwan, people add fresh basil leaves into thick soups (*gēngtāng*). They also eat fried chicken with deep-fried basil leaves (NWE, 2024). Basil is sometimes used with fresh fruit and in fruit jams and sauces—in particular with strawberries, but also raspberries or dark-colored plums. Arguably, the flat-leaf basil used in Vietnamese cooking, which has a slightly different flavor, is more suitable for use with fruit (NWE, 2024). Lemon basil is widely used in Indonesia, where it is called *kemangi* and served raw, together with raw cabbage, green beans, and cucumber, as an accompaniment to fried fish or duck. Its flowers, broken up, are a zesty salad condiment (NWE, 2024). When soaked in water the seeds of several basil varieties become gelatinous, and are used in Asian drinks and desserts such as *falooda* or *sherbet*. Such seeds are known variously as *sabja*, *subja*, *takmaria*, *tukmaria*, *falooda*, or *hôt é* (NWE, 2024). Basil has been a staple in culinary preparations for thousands of years, enhancing the flavor of dishes, sauces, condiments, soups, stews, and more. It blends well with other herbs and is crucial in teas, oils, cheeses, liqueurs, and alcoholic beverages. Basil essential oil is commercially valuable, utilized in various industrial products, including beverages, prepared foods, dental products, fragrances, and soaps (Bashyal, 2024). Basil is consumed in relatively low amounts but offers significant health benefits due to its high levels of antioxidants and minerals. Although precise

quantities for health benefits are not established, basil is calorie-free, rich in dietary fiber, and minerals. It is available in health food stores as basil tea and oil. Basil is a popular food additive, providing a distinctive flavor and aroma, making it a great addition to various dishes (Bashyal, 2024). Basil is commonly used fresh in recipes. In general, it is added at the last moment, as cooking quickly destroys the flavor. The fresh herb can be kept for a short time in plastic bags in the refrigerator, or for a longer period in the freezer, after being blanched quickly in boiling water. The dried herb also loses most of its flavor, and what little flavor remains tastes very different, with a weak coumarin flavor, like hay (UIC, 2024). Basil is one of the main ingredients in pesto—a green Italian oil-and-herb sauce. Its other main ingredients are olive oil, garlic, and pine nuts. The Chinese also use fresh or dried basil in soups and other foods. In Taiwan, people add fresh basil leaves to thick soups. Basil (most commonly Thai basil) is steeped in cream or milk to create an interesting flavor in ice cream or chocolates (such as truffles). The leaves are not the only part of basil used in culinary applications, the flower buds have a more subtle flavor and they are edible. Thai basil is also a condiment in the Vietnamese noodle soup, phở (UIC, 2024). Basil acts principally on the digestive and nervous systems, easing flatulence, stomach cramps, colic, and indigestion. It prevents or relieves nausea and vomiting, and assists to kill intestinal worms. It has a mildly sedative action, proving useful in treating nervous irritability, tiredness, depression, anxiety, and insomnia. It may also be taken for epilepsy, migraine and whooping cough. Basil has been traditionally taken to increase breast milk production. Applied externally, basil leaves act as an insect repellent. The juice from the leaves brings relief to insect bites (AFF, 2012). Basil is an annual herb of the mint family (Lamiaceae), grown for its aromatic leaves. Basil is likely native to India and is widely grown as a kitchen herb. The leaves are used fresh or dried to flavour meats, fish, salads, and sauces; basil tea is a stimulant. Basil is commonly used as a fresh or dried herb in cooking and is popularly used in beverages in Southeast Asia. Essential oil can be extracted from the leaves and used in cosmetics, dental products and perfume (Plantvillage, 2024).

Medicinal Uses: Basil has been used as a remedy for common health problems for thousands of years. This herb is believed to help with (Myspicer, 2014) poor digestion, headaches, the common cold, flatulence, improve memory, vomiting, anxiety, motion sickness, high cholesterol and treatment for burns and cuts. Basil has been used as a folk remedy for an enormous number of ailments, including boredom, cancer, convulsion, deafness, diarrhea, epilepsy, gout, hiccup, impotency, insanity, nausea, sore throat, toothaches, and whooping cough. Basil has been reported in herbal publications as an insect repellent. Recent scientific research has investigated the health benefits associated with basil's essential oils. Studies reveal the anti-viral, anti-microbial, antioxidant, and anti-cancer properties of the oils; further research is underway (Sullivan, 2009). Sweet basil traditionally has been used medicinally for a variety of conditions, including bronchitis, the common cold, influenza, muscle pain, and insect bites. The seeds are used for their medicinal properties in Ayurveda, the traditional medicinal system of India. Recently, there has been much research into the health benefits conferred by the essential oils found in basil. Some scientific studies have suggested that compounds in basil oil have potent antioxidant, anti-cancer, anti-viral, and anti-microbial properties. In addition, basil has been shown to decrease the occurrence of platelet aggregation and experimental thrombus in mice. Basil, like other aromatic plants such as fennel and tarragon, contains estragole, a known carcinogen (cancer-causing agent) and teratogen (birth defects causing agent) in rats and mice. While human effects are currently unstudied, the rodent experiments indicate that it would take 100–1,000 times the normal anticipated exposure to become a cancer risk (NWE, 2024).

Basil provides a good source of β -carotene, magnesium, as well as iron, calcium, potassium, and vitamin C. That said, people typically do not eat herbs in sufficient amounts to provide a significant source of vitamins or minerals in the daily diet – though basil is sometimes consumed as a tincture, where the concentration of specific compounds is likely going to be higher. Furthermore, the Lamiaceae family, which includes basil, sage, and thyme, has also long been recognized as a rich source of diverse and unique anthocyanins, with the deep purple pigmented basil of the ornamental and herb trade provide a potential new source of anthocyanins. The important (health) role played by various culinary herbs in the management of gut microbiota has recently also been acknowledged. However, a survey of 500 top restaurateurs in southern California revealed that few of them (21%) used culinary herbs such as basil for their putative health benefits (Spence, 2024). Research has explored the pharmacological characteristics of basil, revealing its effectiveness against fungal, viral, bacterial, and protozoal infections. Basil shows potential in inhibiting the growth of carcinogenic cells and has applications in HIV treatment. Studies indicate its effectiveness against various diseases, including fevers, coughs, flu, asthma, bronchitis, and its ability to lower cholesterol levels (Bashyal, 2024). Basil provides numerous benefits, including antioxidant properties, anticancer activity, radioprotection, antimicrobial effects, anti-inflammatory actions, immunomodulation, adaptogenic properties, antidiabetic activity, and more. The wide-ranging uses of basil make it a valuable and versatile herb with potential health-promoting effects.

Traditional Medical Uses: Basil boasts an extensive list of traditional medical uses, treating conditions from colds to malaria. Different cultures use basil for various ailments, such as earaches, menstrual irregularities, arthritis, and more. It is employed in homeopathy and considered anthelmintic, anti-emetic, and antidiarrheal in different regions (Bashyal, 2024). Basil is used in folk medicine practices, such as those of Ayurveda or traditional Chinese medicine (Wikipedia, 2024). The leaves and infusions of *O. basilicum* are widely used in traditional medicine. In some Mediterranean areas, such as Eastern Morocco, they are used to decrease plasma lipid content, while the Santhal tribe of India use sweet basil for headache, earache, cough, cold, inflammation, snake bite and rabies. Other reported medicinal uses of basil leaves include the treatment of diarrhoea, dysentery, constipation, flatulence and worms; as an analgesic and insect repellent; to relieve the symptoms of bronchitis, flu, colds, coughs and sinusitis; and as a cure for rheumatism, muscle aches, gout and exhaustion. The leaves are also reported to be effective in the treatment of warts; an ointment made of basil leaves can be used as a treatment for insect bites and can be applied directly to the skin as a cure for acne (Pushpangadan and George, 2012a). The juice expressed from the leaves also has a number of therapeutic uses: it relieves the symptoms of cold and cough, and those of croup, when mixed with honey. It is also used as a treatment for toothache, earache and headache and can be mixed with camphor to stop nasal haemorrhage. It is said to give lustre to the eyes, and forms an excellent nostrum for the cure of ring worms, scorpion sting and snake bite (Pushpangadan and George, 2012a). Basil seeds

steeped in water and eaten are said to be cooling and very nourishing. The seeds are chewed as a treatment for snake bite. The washed and pounded seeds are used in poultices for unhealthy sores and sinuses, and are also used in **sharbat** for the treatment of chronic constipation and in internal piles. A teaspoon full of seed infused in a tumbler of water with a little sugar, when taken daily, acts as a demulcent in genito-urinary disease; a cold infusion of seeds is said to relieve afterpains of childbirth; and an infusion of seed is also given in fever. The aqueous extract of the seeds is used as a diuretic. Finally, the roots of the plant are used for bowel complaints in children (Pushpangadan and George, 2012a).

Use in Ayurvedic medicine

O. basilicum is referred to as 'barbari' by Bhavamisra. According to Ayurveda, the plant is used for diseases caused by aggravation of Kapha and Vata while the seeds are used for pacifying aggravation of Vata and Pitta. The medicinal properties of *O. basilicum* are described in a number of classical Ayurvedic texts such as the Sushruta Samhita, Charaka Samhita, Ashtangahridaya, Bhavaprakasham, Danwanthari Nighandu and Kaiyadeva Nighandu. In Ayurveda, the whole plant is used to treat cough, asthma, bronchitis, ophthalmia, giddiness, intermittent and malarial fever, catarrh, otalgia, cephalalgia, dyspepsia and spasmodic affections. The plant is considered stomachic, stimulant, carminative, diaphoretic, expectorant, diuretic and antipyretic (Pushpangadan and George, 2012a). The type used in Italian food is typically called sweet basil, as opposed to Thai basil (*O. basilicum* var. *thyrsiflora*), lemon basil (*O. X citriodorum*) and holy basil (*Ocimum tenuiflorum*), which are used in Asia. While most common varieties of basil are treated as annuals, some are perennial in warm, tropical climates, including holy basil and a cultivar known as 'African Blue' (Pubchem, 2024).

Insecticide and insect repellent: Studies of the essential oil have shown insecticidal and insect-repelling properties, including potential toxicity to mosquitos. The essential oil is found by Huignard *et al.* 2008 to inhibit electrical activity by decreasing action potential amplitude, by shortening the post hyperpolarization phase, and reducing the action frequency of action potentials. In Huignard's opinion this is due to the linalool and estragole, the amplitude reduction due to linalool, and the phase shortening due to both (Wikipedia, 2024). *Callosobruchus maculatus*, a pest which affects cowpea, is repelled by the essential oil. The essential oil mixed with kaolin is both an adulticide and an ovicide, effective for three months against *C. maculatus* in cowpea. The thrips *Frankliniella occidentalis* and *Thrips tabaci* are repelled by *O. basilicum*, making this useful as an insect repellent in other crops. The pests *Sitophilus oryzae*, *Stegobium paniceum*, *Tribolium castaneum*, and *Bruchus chinensis* are evaluated (Wikipedia, 2024). Basil exhibits powerful insecticidal properties, offering an environmentally friendly alternative to synthetic insecticides. Studies indicate repellent effects against houseflies and red flour beetles, showcasing its potential as a natural insect repellent (Bashyal, 2024). Studies of the essential oil have shown insecticidal and insect-repelling properties, including potential toxicity to mosquitos. The essential oil is found by Huignard *et al.* 2008 to inhibit electrical activity by decreasing action potential amplitude, by shortening the post hyperpolarization phase, and reducing the action frequency of action potentials. In Huignard's opinion this is due to the linalool and estragole, the amplitude reduction due to linalool, and the phase shortening due to both (Inaturalist, 2024). *Callosobruchus maculatus*, a pest which affects cowpea, is repelled by the essential oil. The essential oil mixed with kaolin is both an adulticide and an ovicide, effective for three months against *C. maculatus* in cowpea. The thrips *Frankliniella occidentalis* and *Thrips tabaci* are repelled by *O. basilicum*, making this useful as an insect repellent in other crops. The pests *Sitophilus oryzae*, *Stegobium paniceum*, *Tribolium castaneum*, and *Bruchus chinensis* are evaluated by Deshpande *et al.* 1974 and '77 (Inaturalist, 2024).

Bacterial and fungal inhibition: The essential oil of the leaf and terminal shoot is effective against a large number of bacterial species including *Lactiplantibacillus plantarum* and *Pseudomonas* spp. The essential oil of the leaf and terminal shoot is also effective against a large number of fungal species including *Aspergillus* spp., *Candida* spp., *Mucor* spp., and *Geotrichum candidum* (Wikipedia, 2024).

As a flavouring agent in foods

Basil leaves are widely used for flavouring purposes in soups, meat pies, fish dishes, certain cheeses, tomato salads, cooked cucumber dishes, cooked peas, squash, and string beans as well as vinegars and oils. Chopped basil may be sprinkled over lamb chops before cooking. Basil is an important seasoning in tomato paste products in Italy, and is often used with or as a substitute for oregano in pizza toppings, spaghetti sauces, meat balls, or in macaroni and cheese bakes (Pushpangadan and George, 2012a). The essential oil of *O. basilicum* obtained by distillation is used in a number of food products as a flavouring agent and is also used in perfumery thanks to its aromatic characteristics. It contains cineol, pinene, methyl chavicol, d-camphor and ocimene. The major aroma constituents of basil are 3,7-dimethyl-1,6-octadien-3-ol (linalool; 3.94 mg/g), 1-allyl-4-methoxy benzene (estragole; 2.03 mg/g), methyl cinnamate (1.28 mg/g), 4-allyl-2-methoxyphenol (eugenol; 0.896 mg/g), and 1,8-cineole (0.288 mg/g) (Pushpangadan and George, 2012a). Examples of food products that may be flavoured with basil essential oil include confectionery, baked goods, condiments, spiced meats, ice creams, puddings, liquors and non-alcoholic beverages. The oil may also be used as a flavouring for certain dental and oral hygiene products (Pushpangadan and George, 2012a).

Ritualistic uses of basil: Basil serves a ritualistic function in some countries/cultures. The use of basil in grave adornment, religious ceremony, and also as a scented garland held by the dead prior to burial. Sutton also describes how basil-scented water is used in other religious ceremonies, and basil is touched prior to shaking hands when people engage in introductory handshake. Pots of basil are apparently also used to help deodorize Greek offices. Greeks love the smell of basil, and it is seen as representing home to them – One famous Greek folklorist even went so far as to suggest that: “A flowerpot of basil can represent the soul of a people better than a drama of Aeschylus” (Spence, 2024). Basil has diverse ritualistic uses, ranging from culinary to religious.

Historical beliefs associate basil with death in Europe, while in Italy, it was worn for courting. Hindus believe being buried with basil ensures a ticket to heaven. The English used it to repel pests and evil spirits. In Portugal, basil is given as a gift on religious holidays, and in various Orthodox churches, it is used in holy water preparation (Bashyal, 2024).

Side Effects of Basil Plant

Impact on Pregnancy: Consuming excessive amounts of basil during pregnancy may pose potential risks. Basil has been reported to have the potential to induce uterine contractions, making it advisable for pregnant women to consult with a healthcare professional before including basil in their diet (Bashyal, 2024).

Fertility Concerns: Preclinical studies suggest that basil may have an impact on fertility. Women who are attempting to conceive or breastfeeding are advised to avoid basil consumption. Additionally, regular intake of basil leaves might also influence fertility levels in men, potentially reducing sperm count (Bashyal, 2024).

Eugenol Overdose: Basil contains eugenol, a potent compound known for its anti-inflammatory, antibacterial, and antiseptic properties. While these properties can be beneficial, an overdose of eugenol may lead to adverse effects. Symptoms of eugenol overdose include shallow breathing, inflammation of the mouth and throat, nausea, rapid heartbeat, seizures, and dizziness. Care should be taken to avoid excessive intake of basil, especially in concentrated forms (Bashyal, 2024).

Liver Cancer Risk (Internal Use): When taken by mouth as a medicine, basil is considered POSSIBLY UNSAFE due to the presence of estragole, a chemical that might increase the risk of liver cancer. It is crucial to be cautious about the amounts consumed, and medical consultation is recommended (Bashyal, 2024).

Skin and Aromatherapy Safety: Basil essential oil is considered POSSIBLY SAFE when applied to the skin in concentrations of up to 6% for 12 weeks. However, caution should be exercised to prevent skin irritation. The safety of basil when inhaled as aromatherapy is uncertain, and reliable information regarding potential side effects is lacking (Bashyal, 2024).

Basil Products

Culinary Products (Bashyal, 2024).

Fresh Basil Leaves: Used in a variety of dishes, particularly in salads, pastas, and pizzas.

Dried Basil Leaves: A convenient option for adding basil flavor to dishes year-round.

Basil Pesto: A popular sauce made from basil, garlic, pine nuts, Parmesan cheese, and olive oil.

Basil-infused Olive Oil: Olive oil infused with basil, adding a fragrant and flavorful touch to cooking.

Basil Vinegar: Vinegar infused with basil, offering a unique flavor for dressings and marinades.

Essential Oil Products (Bashyal, 2024).

Basil Essential Oil: Extracted from basil leaves, used in aromatherapy and for its potential therapeutic benefits.

Basil-scented Candles: Candles infused with basil fragrance for a pleasant and calming atmosphere.

Aromatherapy Diffuser Oils: Essential oils, including basil, used in diffusers for aromatherapy.

Skincare Products (Bashyal, 2024).

Basil-infused Lotions: Lotions incorporating basil for potential skin benefits and a refreshing scent.

Basil-infused Creams: Creams with basil extract, possibly used for skin nourishment.

Basil Face Masks: Skincare masks featuring basil for its antioxidant properties.

Basil-infused Soaps: Soaps containing basil extract, known for its aromatic and cleansing qualities.

Herbal Tea Products (Bashyal, 2024).

Herbal Tea Bags: Tea bags containing dried basil leaves for a herbal infusion.

Basil Infusions: Basil leaves used for making herbal teas with various flavor profiles.

CULTIVATION

Propagation

Basil, a popular and versatile herb, is not only easy to grow but can also be propagated effortlessly. There are two primary methods for propagating basil—planting seeds and using cuttings (Bashyal, 2024).

Propagating Basil from seeds: Ensure the planting area receives six to eight hours of sunlight daily. Use soil with a neutral pH for optimal growth. Plant basil seeds in rows, covering them with about 1/4-inch of soil. Once plants reach a few inches in height,

thin them out to 6 to 12 inches apart. Basil can be planted indoors as well. Choose a sunny location for the pot and water the basil every seven to 10 days.

Propagating Basil from Cuttings: Select a 4-inch basil cutting just below a leaf node. Remove leaves from the cutting, leaving about 2 inches from the end. Ensure the cutting has not yet flowered. Place the cutting in a glass of water on a windowsill. Change the water every few days until roots grow to about 2 inches. This process takes two to four weeks. Once roots are 2 inches or longer, plant the cutting in a pot indoors. Position the planter in direct sunlight.

Pruning, Flowering, and Seeding

Once a stem produces flowers, foliage production stops on that stem, the stem becomes woody, and essential oil production declines. To prevent this, a basil-grower may pinch off any flower stems before they are fully mature. Because only the blooming stem is so affected, some stems can be pinched for leaf production, while others are left to bloom for decoration or seeds. Picking the leaves off the plant helps promote growth, largely because the plant responds by converting pairs of leaflets next to the topmost leaves into new stems. Once the plant is allowed to flower, it may produce seed pods containing small black seeds, which can be saved and planted the following year. If allowed to go to seed, a basil plant will grow back the next year (Inaturalist, 2024).

Growing Conditions

Basil is sensitive to cold, with best growth in hot, dry conditions. It behaves as an annual if there is any chance of a frost. However, due to its popularity, basil is cultivated in many countries around the world. Production areas include countries in the Mediterranean area, those in the temperate zone, and others in subtropical climates (Inaturalist, 2024). In Northern Europe, Canada, the northern states of the U.S., and the South Island of New Zealand, basil grows best if sown under glass in a peat pot, then planted out in late spring/early summer (when there is little chance of a frost); however, it can also thrive when planted outside in these climates. Additionally, it may be sown in soil once chance of frost is past. It fares best in well-drained soil with direct exposure to the sun (Inaturalist, 2024). Although basil grows best outdoors, it can be grown indoors in a pot and, like most herbs, will do best on a sun-facing windowsill, kept away from extremely cold drafts. A greenhouse or row cover is ideal if available. It can, however, even be grown in a basement under fluorescent lights. Supplemental lighting produces greater biomass and phenol production, with red + blue specifically increasing growth and flower bud production. UV-B increases the volatiles in *O. basilicum* essential oil, which has not been reproducible in other plants, and so may be unique to the genus or even to this species (Inaturalist, 2024). Basil plants require regular watering, but not as much attention as is needed in other climates. If its leaves have wilted from lack of water, it will recover if watered thoroughly and placed in a sunny location. Yellow leaves towards the bottom of the plant are an indication that the plant has been stressed; usually this means that it needs less water, or less or more fertilizer. Basil can be propagated reliably from cuttings with the stems of short cuttings suspended in water for two weeks or until roots develop (Inaturalist, 2024).

Cultivation

Basil requires warm temperate or mediterranean conditions, and should do well in most areas of the republic of South Africa. It is best cultivated in subtropical, temperate regions. Optimum temperature for germination is 20 °C, with growing temperatures of 7 to 27 °C. The plant is susceptible to frost and cold temperatures and therefore develops best in long-day, full-sun conditions. Basil cannot tolerate drought stress as the plant tissue is very tender. Annual rainfall of 700 mm is the minimum for dryland cultivation. Regular irrigation has to supplement rainfall where lacking, to maintain constant growth of the crop. Although basil may be irrigated with overhead sprinklers, drip irrigation is better. Plants grown with drip irrigation are less likely to develop foliar diseases than sprinkle-irrigated plants because the foliage stays dry. Black plastic mulch will enhance good yields of high-quality clean leaves (AFF, 2012). Basil requires well-drained, fertile soils with a high organic matter content. It grows well in soils with a pH ranging from 4,3 to 8,2 and an optimum pH of 6,4. Basil has medium, deep roots and a high water requirement. Because moisture is important for a good basil crop, mulching the area will not only discourage weeds, but will maintain the moisture level of the soil, keeping the plants healthy. Sprinkle-irrigated plants because the foliage stays dry. Black plastic mulch will enhance good yields of high-quality clean leaves (AFF, 2012). Basil grows easily, however, it is highly susceptible to cold weather. For a producer who wants an early crop, seeds can be sown in seed trays. While in the greenhouse, the plant tops can be trimmed to encourage growth and lateral branching, and then be transplanted into the field when these have reached 15 cm in height, in approximately 4 to 6 weeks. The transplants have to be hardened off by withholding some water and exposing the plant to outside conditions during the day with protection at night, before planting into the field. Basil may be cultivated either as a field-grown crop or in a greenhouse. To ensure that the seed is true to type, high-quality seed should be obtained from reputable suppliers. Quality, trueness to type, high germination percentage and reliability are very important when considering the purchasing of seed. With direct seeding, an 80 to 90 % germination rate can be expected. Basil can also be propagated by means of cuttings (AFF, 2012). Herbal and essential oil crops grown on natural soils yield products that are of high quality and in demand globally. Producers are advised to have the soil analysed at a laboratory to check for mineral deficiencies and excesses, organic status and carbon ratios. Soil analysis will guide the producer in correcting the nutritional status of the soil. Soil fertility levels have to be within acceptable ranges before a soil-building programme is started. Correct the soil pH according to analysis and soil type. Fertiliser use has to be planned according to whether the crop will be grown inorganically or organically. Soil preparation has to be done according to good cultivation practices. Apply suitable soil preparation practices according to the farming operation (rip, plough, disc, harrow, contour, etc.). If mechanical harvesting and weed control is envisaged, prepare row widths adapted to the machinery to be used.

Producers who use the correct soil treatment will experience the benefit of producing crops of high value with less input in terms of weed, pest and disease control (AFF, 2012). Planting density/spacing High plant populations are recommended for essential oil and dried basil, while the fresh market requires long stems and larger leaves, a lower plant population is therefore recommended. The recommended plant spacing is 15 to 30 cm in the row, and 50 cm to 1 m row width. The distance between the beds will be dependent on available cultivation equipment and end use. Double-row plantings on beds between 0,5 and 1, 2 m wide are used with mechanical cultivation. Plant populations of 60, 000 to 90, 000 plants per hectare are used by most commercial producers. Large commercial producers use a mechanical planter or a vegetable seeder. The seeding rate will depend on the desired planting density, which, in turn, depends on the end market. The germination rate of the seed should be 80 to 95 %, and seeds should not be planted if the germination percentage is less than 70 %. For direct seeding, seed is planted only 3 to 6 mm deep at a spacing of 5 cm apart to ensure 80 to 90 % germination. The plants can then be thinned after emergence to the desired population. The soil should be kept moist for the seeds to germinate. Basil can be direct seeded or transplanted to the field in early or late spring, from august to october, after all danger of frost has passed. It can be planted in a nursery at an earlier date to protect it from cold and frost and then transplanted into the field when ready (AFF, 2012).

Fertiliser applications depend on the soil type, soil analysis recommendation and fertiliser applications for the previous crop. Overfertilising basil will result in fertile vegetal growth, but flavour will be impaired. Basil responds well to moderate fertility. The quantity of fertiliser to be applied will depend on the soil analysis results. If basil is cultivated for essential oil, it has to be fertilised sparingly as this can decrease the fragrant oils (AFF, 2012). Basil requires water in form of rain or irrigation regularly, throughout the growing season in order to maintain constant growth. Basil may be irrigated with sprinklers, however, drip irrigation is a better option. Plants grown with drip irrigation are less likely to develop foliar diseases than overhead irrigated plants because the foliage stays drier (AFF, 2012). Weed control is critical because competition with weeds decreases the quality of basil leaves. Cultivation practices such as high plant populations, shallow cultivation, decreasing row spacing and mulching can be practised to keep weed populations low. Mechanical cultivation and manual weeding are some of the weed control methods that can be used (AFF, 2012). As basil is such a delicate plant, it will naturally attract pests of different kinds, for example:

- Chewing-type damage: beetles, slugs, leafminers, caterpillars, grasshoppers.
- Sucking-type damage: leafhoppers, thrips, whitefly species. for prospective producers of herbal and essential oil crops, the following pest control guidelines are recommended (AFF, 2012).

Information on basil diseases and control is very limited. Basil is a special crop with only few pesticides registered that can be used on the crop. Natural control, such as parasitic wasps, spiders, and other general predators, can be of assistance in keeping pest populations at moderate levels. *Bacillus thuringiensis*, a biological control agent that kills a variety of caterpillars, can be used on basil. Dichotomaceous earth can be used for snails. Other organic methods such as reflective mulches, beneficial insects, insecticidal soaps, plant extracts, pest traps, handpicking of pests and organic insecticides can be used. Producers should therefore rely on early recognition and use of cultivation practices such as the use of windbreaks and rain shelters to prevent and manage diseases. By recognising the first symptoms of disease, producers can remove diseased plants and continuously monitor fields for signs of pathogen recurrence or spread of disease (AFF, 2012). Some producers of essential oils harvest basil only once and then during the full flowering stage. Other producers harvest the crop just as flowering commences and allows for regrowth to have additional harvests during the same season. Up to 4 cuttings are possible. Commercial producers use a modified sickle-bar mower with an adjustable cutting height for harvesting. For fast regrowth, cuttings can be made at 100 to 150 mm above the ground. Harvesting should be done in warm, sunny weather, which will allow for a higher yield of oil. Make sure not to irrigate for a few days before harvest (AFF, 2012). Leaves can be harvested when needed. The foliage should be cut at least 10 to 15 cm above the ground to allow for regrowth and subsequent crop. To ensure a continuous supply of leaves, the field harvests or planting dates can be spaced accordingly. Foliage should be harvested before the plants bloom. Basil plants will seed and stop producing leaves if the flower spikes are not removed as these appear. The ideal time to harvest basil that is to be dried, is on a sunny morning, immediately after the dew has evaporated, and before the day becomes too warm. When harvesting basil for the fresh market, make the cuts 5 mm above a node and at a height of 10 to 15 cm, and leave sufficient foliage on the plant so that it can continue with healthy growth (AFF, 2012). Leaf cuttings of basil for the fresh market may be harvested from one to five times per season, depending on the area involved and the length of the growing season. Leaves should first be washed and cleaned, removing the weeds and extraneous materials. The basil should be refrigerated as soon as possible after cutting, preferably in the field. Only the highest-quality basil with the best colour and aroma should be used for fresh market sales. Before distillation, the basil plant is dried for 1 to 3 days at temperatures below 40 °c. The essential oil and oleoresin are extracted from the leaves and flowering tops via steam distillation (AFF, 2012).

Grading, Packaging, Storage, Marketing: Colour, aroma and texture are the key elements for producing a quality fresh crop for the market. The essential oils of basil are of complex and variable composition. Within the species, several different chemical races exist, and the climate, soil, cultivation practices and time of harvest influence not only the quantity, but also the composition of the essential oil. The most important aroma components are 1,8 cineol, linalool, citral, methyl chavicol (estragole), eugenol and methyl cinnamate, although not necessarily in this order, in fact, hardly any basil type contains all of these compounds in significant quantities. Other compounds may also be present, depending on cultivar. African species often contain camphor (AFF, 2012).

Fresh basil is very soft and damaged easily by rough handling, dehydration, and chilling. To ensure and maintain product quality, minimise bruising when harvesting and packaging. Harvested basil is usually dipped in cold water to remove soil particles and some of the insects that are not strongly adhering to the plant. It is then dried off prior to sorting and packing the product. Basil

may be packed in bulk or packed in bunches, propylene bags or similar packaging used for herbs. For a dried product, basil should be cut 15 cm above the ground. The foliage is stripped from the stems. Drying should occur in a warm, well-ventilated place to retain a good green colour. Commercial driers are used on bigger farms. Packaging in smaller containers is sometimes done where producers have the necessary facilities (AFF, 2012). Essential oils are stored in air-tight fluorinated plastic, treated aluminum, dark glass or ceramic containers and stored in a cool, dry place. Fresh basil can be stored at a temperature of between 8 and 10 °C to prolong its shelf-life. Basil is, however, highly sensitive to chilling, with typical symptoms of damage being blackening of leaves and aroma loss. Fresh basil can be stored for 7 to 10 days at the recommended temperature. Dried leaves are stored in dark, air-tight containers and are therefore marketed (AFF, 2012). Fresh basil is marketed at fresh produce markets, supermarkets, hotels and restaurants, specialty food outlets such as pizza places, wholesalers and retailers. Markets for the dried product have to be established before production begins. The quality of the product is determined by taste, flavour, moisture content and cosmetic appearance for the fresh market, as well as volatile oil content and total insoluble ash content for the processing market. The major market in the world for essential oils is the United States, followed by Japan and Europe. However, production continues to be concentrated in Europe, with seven of the world's largest essential oil processing firms. In the United States, the major users of essential oils are the soft drink companies. Japan accounts for 10 % of the world demand. The Canadian market is dominated by the United States perfume and flavouring industry. France is dominating the world perfumery market, and Switzerland is one of the leaders in the pharmaceutical field. Britain and India are known to feature strongly in the flavouring sector. The essential oil industry is characterised by a number of difficulties, including lack of stable quality, inconsistent supplies and variability of active ingredients owing to environmental effects. This has encouraged many of the end users to depend on synthetic oils in an effort to eliminate these problems. The result is a weaker market for naturally produced essential oils. With the increased interest in "natural" products and new health consciousness of the public, as well as the fact that a natural product is perceived to have a superior quality, there is an opportunity to effectively market naturally produced essential oils, should the problems mentioned be addressed. Price differences exist between the types presented according to buyer requirements (AFF, 2012).

Production Levels: Today, basil is cultivated in many Asian and Mediterranean countries. Basil is cultivated extensively in France, Egypt, Hungary, Indonesia, Morocco and the United States, Greece and Israel. The European sweet basil is cultivated and distilled in Europe, in the Mediterranean region. The United States crops are considered to be of the highest quality, producing the finest odour. The USA is the biggest producer and importer (AFF, 2012).

Harvesting: Basil leaves can begin to be harvested any time after the plants have reached a height of 15–20 cm (6–8 in). Harvest leaves by pinching the leaves from the tips of the stems to encourage the more branching. Leaves should be pinched regularly to keep the plants productive and prevent them from going to seed (Plantvillage, 2024).

Diseases: Basil suffers from several plant pathogens that can ruin the crop and reduce yield. Fusarium wilt is a soil-borne fungal disease that will quickly kill younger basil plants. Seedlings may be killed by *Pythium* damping off. A common foliar disease of basil is gray mold caused by *Botrytis cinerea*; it can cause infections post-harvest and is capable of killing the entire plant. Black spot can be seen on basil foliage and is caused by the fungus genus *Colletotrichum*. Downy mildew caused by *Peronospora belbahrii* is a significant disease, as first reported in Italy in 2003. It was reported in Florida in 2007 and by 2008 had spread along the eastern United States, reaching Canada. Basil cultivars resistant to *P. belbahrii* have been developed.

Sweet basil suffers from several plant pathogens that can ruin the crop and reduce yield. Fusarium wilt is a soil-borne fungal disease that will quickly kill younger basil plants. Seedlings may also be killed by *Pythium* root rot. A common foliar disease of basil is gray mold caused by *Botrytis cinerea*, which also can cause infections post-harvest and is capable of killing the entire plant. Black spot can also be seen on basil foliage and is caused by the fungus genus *Colletotrichum* (NWE, 2024).

Basil suffers from several plant pathogens that can ruin the crop and reduce yield. Fusarium wilt is a soil-borne fungal disease that will quickly kill younger basil plants. Seedlings may be killed by *Pythium* damping off. A common foliar disease of basil is gray mold caused by *Botrytis cinerea*; it can cause infections post-harvest and is capable of killing the entire plant. Black spot can be seen on basil foliage and is caused by the fungus genus *Colletotrichum*. Downy mildew caused by *Peronospora belbahrii* is a significant disease, as first reported in Italy in 2003. Non-pathogenic bacteria found on basil include *Novosphingobium* species (Inaturalist, 2024).

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