THERAPEUTIC POTENTIAL AND PHYTOCHEMISTRY OF NATURAL HERBALS OF FAMILY LAMIACEAE: *OCIMUM SANCTUM* L. AND *OCIMUM BASILICUM*

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Contents

Summary

Rich biodiversity of natural products offers a vast area for phytochemical and pharmacological investigations. Therefore, at present over 80% of known (approximately 30,000) natural products have originated from plants worldwide. Amongst some of the astonishing herbs, family Labiate (syn. Lamiaceae) includes more than 252 genera and 7000 species. The genus *Ocimum* is one of the extensively used member of Lamiaceae family and comprising 150 species. This study elaborated the vast global applicability of *Ocimum bascilicum* and *Ocimum sanctum* extracts as well as their essential oils in recent markets as important components in organic cosmetics, perfumery, food packaging, storages, neutraceuticals, ethnomedicinal, therapeutic and pharmacology. Moreover, *O. bascilicum* and *O. sanctum* could be an important valuable source of substances, which possesses remarkable antioxidant, antibacterial, antifungal, anti-hepatotoxicity, anticancer, antiviral, antidiabetic, antimicrobial, anti-inflammatory, analgesic and various other activities. Thus, a systematic review was performed to investigate the phytochemical and pharmacological potential of *O. sanctum* and *O. basilicum* to search the possibilities of these metabolites in the health sector for discovery and development of new drugs. Additionally, essential oils of *O. sanctum* and *O. basilicum* were developed for the determination of various micro and nano herbal drug substances via nanotechnology. They also have important roles in emering development of herbal cosmacuticals which reduces the risk of side effects of some synthetic chemicals.

In this context, the proposed chapter is the outcome of various collaborative works from all over the world, which includes a brief introduction along with historical content. Thereafter, phytochemistry and biological potential of extracts as well as essential oils of both species will be discussed. Ending section of this chapter highlights the advantages, conclusions and future prospectives.

1. General Introduction

Despite the various advancements in diagnosis and surgery, today's world is fretting with various chronic diseases. Recently, an infectious disease COVID-19 caused by corona virus, is an example of that how the world is suffering with newly emerging diseases. So, the priority in the present times is to build an adequate immune system to fight against diseases which is a big challenge for scientists and researchers across the world. Strong immune system plays a powerful role in the prevention of infections or viruses. During the past few years, the interest in the natural products-based medication has considerably increased for strengthening the immunity because of their mild to no side effects. Natural products are rich and wide sources of potentially active secondary metabolites such as terpenoids, alkaloids, and flavonoids. These secondary metabolites contain considerable range of antioxidant, antimicrobial, antiviral, anti-inflammatory, anti-diarrheal, anti-diabetic, cardio protective, analgesic, antipyretic, anti-tumor, anti-stress, anti-allergic, antihypertensive, anticancer and many more activities. Moreover, approximately 13000 plant species have been found which are being used as drug throughout the globe.

The use of natural products for sustainable development has been explored globally in few last decades. Among the species known for therapeutic potential, the aromatic species and their essential oils are more commercially valuable. Essential oils are also a natural source of antioxidants and widely acceptable by the consumers. Nowadays, principally active components of essential oil extracted from aromatic plant species are being utilized in various clinical applications, food and flavorings industries, cosmetics and perfume markets. Over the last decades, the interest in essential oil and its trends in beauty products have grown significantly. Generally, essential oils are the mixture of volatile compounds, which show low stability towards heat, oxygen and moisture. Therefore, various new techniques have been developed to prevent them from degradations. Drying is one of the promising techniques which removes contamination and increases self-life of the herbal products. Recently, natural products like herbal tea, soup, syrup and decoction are vastly consumed and drying technique could be another way of increasing consumption of natural based products for long time. Previous studies reported that drying of herbal species can improve their bio activities and potential for various sicknesses. Nano- and micro- encapsulation of the essential oil is the most convenient method to protect it from microorganism, fungus and enhances direct or indirect uses of essential oil to cure various human ailments.

Some of the most important and popular aromatic herbs are lavender, rosemary, peppermint, sage, fennel, artemisia chameleon, oregano, coriander, red spider lily, thyme, geranium also including the king of herbs '*Ocimum*". *Ocimum* has been famous as royal herb in French and sacred herb in India. In Hinduism, *Ocimum* (Tulsi) has great spiritual importance and used in worship (Figure 1).

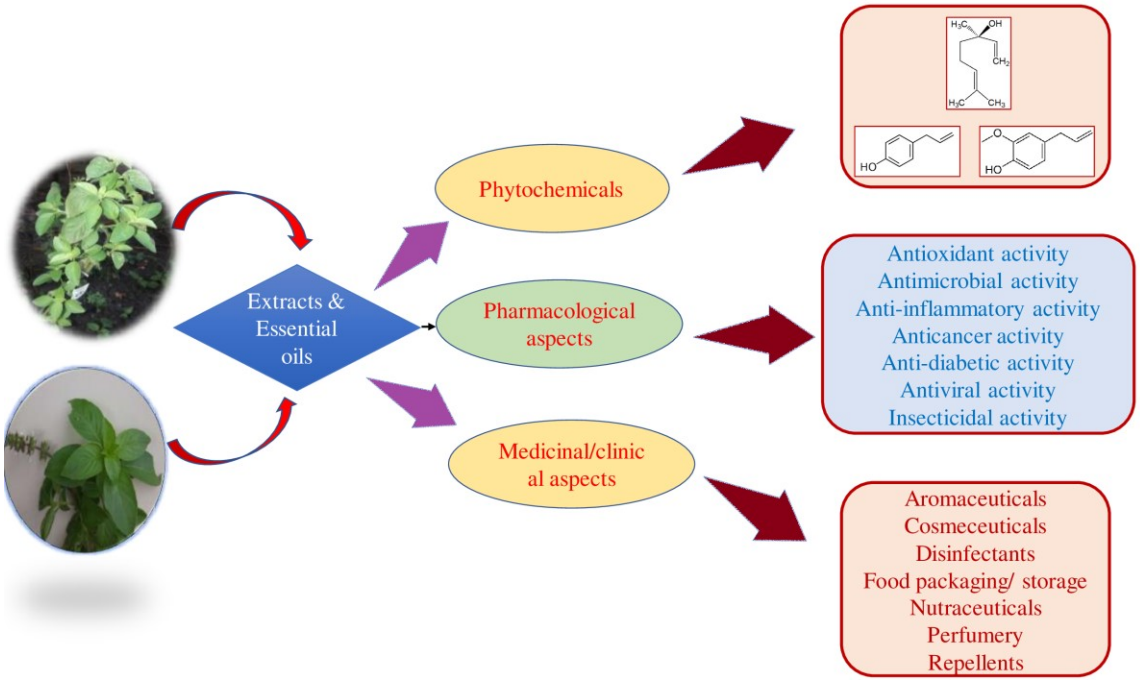

Figure 1. Phytochemical and pharmacological potential of *O. sanctum* L. and *O. basilicum* L.

2. History behind *Ocimum*

Ocimum commonly known as Tulsi, which is mentioned in the ancient language of Sanskrit as Tulasi, Ajaka, Krishnamul and its translated meaning is "the matchless one". In Arabic, *Ocimum* is called by the name Raihaan and Habaq. Moreover, in French language, it is popular as Basilic Saint, In Hindu scripture, according to *Padma Purana,* importance of *Ocimum* (Tulsi) in worship was described and mentioned in a chapter of Tulsi Vivah. Tulsi is considered as a goddess and consort of lord Vishnu. Therefore, *Ocimum* (Tulsi) is also called *"Vishnupriya"*. In India, some morphotypes of *Ocimum* species, also known as "Rama or Shri or Lakshmi Tulsi" and "Shyama or Krishna Tulsi" according to their leave's color; the light green and dark purplish respectively. *Ocimum basilicum* is also known by various names such as Basil/Common Basil or Sweet Basil in English, whereas, it is called as *Babui Tulsi* in Hindi and Bengali. The plant is known as *Badrooj, Hebak* or *Rihan* in Arabic; as *Nasabo* or *Sabje* in Gujrati and as *Jangli Tulsi* in Urdu. *Tohrakhurasani* and *Okimon* are the other ascribed names.

2.1. In Ayurveda

Importance of Tulsi in Indian traditional therapeutics system with ancient theories has been indicated in the *Charaka Samhita* (an ancient Sanskrit text on Ayurveda). In Ayurveda, Tulsi has been considered as a medicinal herb and a source of strong aroma containing components for several decades. Its diverse healing potential along with stress relief properties has been earlier mentioned. Tulsi extracts are used to cure common cold, fever, cough, stomach infections and many more.

2.2. In Greek-Unani system

Unani medicine (Yunani) is known for its wide range of adaptability in Muslim culture mostly in South Asia and more recently, in some other parts of Asian countries. Unani medicine is commonly called as Perso-Arabic traditional medicine system and pseudoscientific system. In Unani aromatic herbal system, more than 1000 plants are still in use including Faranjmishk (*Ocimum gratissimum* Linn.) with many folk applications in nostrils, obstruction of brain, common fever etc. Basil was used to produce royal perfumes in Greece, hence it was named as "royal plant".

2.3. In Homeopathy

Among the herbs known for medicinal value, *Ocimum* has wide history of uses in traditional Homoeopathy system. The efficacy of Homoeopathic medicines depends upon the active compounds present in the herbal medicinal plants. Various species of *Ocimum* are major sources of these bioactive components. Therefore, in terms of easy accessibility, high effectiveness, mild to no side effects and economical aspects, the low cost homoeopathic *Ocimum* mother tincture (a mixture or extract of herbal plant) is a good alternative for the primary health care and 70-80% of the world's population uses homoeopathic medicine in day-to-day practices.

2.4. In Tibetan Medicine Systems

For a long time, more than 2000 years, Traditional Tibetan medicine system (formerly called Sowa-Rigpa medicine) had a wide and fanciful history including various unique techniques such as pulse readings, physical therapies, urinalysis and preferred natural herbs to treat illness. In addition, latest statistics suggested that the Tibetan medical system is based upon 2,644 natural plants including *Ocimum* and a total of 3,105 natural medicines are being practiced in daily life. Huge quantities of Tibetan medicines are used in India, Tibet, Ladakh, Nepal, Bhutan, China, Mongolia and Siberia also more recently in many parts of Europe, North America and some other parts of the world.

3. The Lamiaceae Family

Family Lamiaceae (Labiatae), is one of the most important essential oil-bearing families of more than 252 genera and 7000 species. Since ancient, Lamiaceae family is also called as mint family of flowering plants and majorities of them are aromatic, herbage with clinical properties. Best known species of the largest family includes *Lavender, Ocimum, Rosemary, Origanum, Hyssop, Thymus, Sage, Mentha, Nepeta, Perilla* etc. Aromatic species in the family are rich sources of naturally occurring antioxidants and used in various pharmaceuticals, cosmetics, perfumery, food flavoring agents and many other industrial applications. Even though, most of the species are generally cultivated in home gardens for their fresh scent leaves and interesting flowers. Intense fragrance of these aromatic species is also used in aromatherapy. Many of the species of family Lamiaceae which contain essential oil have attained largest economical value in recent years. Their essential oil play major role in cosmetics and perfume market and demand of essential oil is increasing day by day. The well-known *Ocimum* of this family singly composed of 150 species, approximately most of which are aromatic and still in use.

3.1. List of Some *Ocimum* Species Found in India

Ocimum sanctum L.
Ocimum basilicum L.
Ocimum gratissimum L.
Ocimum americanum L.
Ocimum kilimandschricum Gürke
Ocimum filamentosum Forssk.
Ocimum minimum L.

Figure 2 represents the photographs of (a) *O. sanctum* (b) *O. basilicum* (c) *O. gratissimum* (d) *O. americanum*

3.2. Synonyms and Common Name

Ocimum sanctum L.; syn. *O. tenuiflorum* (Holy basil/Tulsi)
Ocimum basilicum L.; syns. *O. album* L., *O. anisatum* Benth. (Basil)
Ocimum gratissimum L. *Ocimum viride* Willd. (Clove basil/African basil)
Ocimum americanum L. (*O. canum* Sims) (Hoary basil)

Ocimum kilimandschricum Gürke (African blue basil)
Ocimum filamentosum Forssk.; syn. *O. adscendens* Willd.
Ocimum minimum L. (Bush basil)

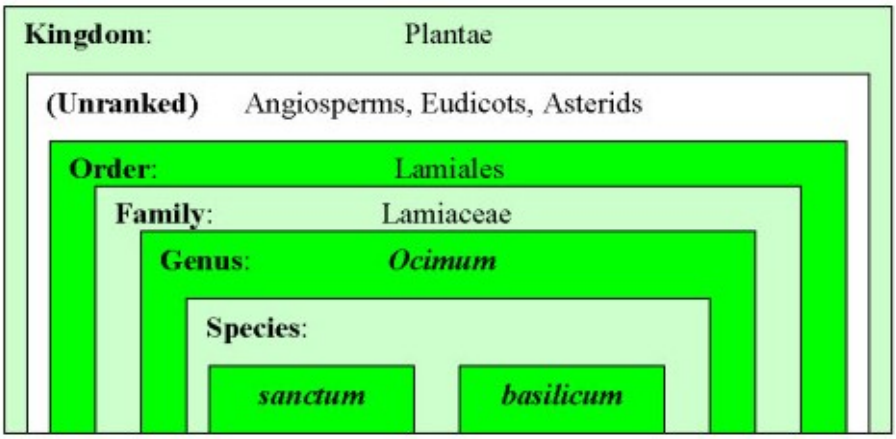

Figure 2. The photographs of (a) *O. sanctum* (b) *O. basilicum* (c) *O. gratissimum* (d) *O. americanum* in natural environment

3.3. Importance of *Ocimum* Genus

The genus *Ocimum* is one of the well-known genera in the Lamiaceae (mints) family. The genus is a big provider of more than 150 species globally. Majority of the *Ocimum* species are aromatic and medicinally valuable. Presence of potentially active compositions has been mentioned in several species of *Ocimum.* It is an important species for research purpose because of its versatile applications, cost-effectiveness, and ease of availability. In this novel pandemic period, when most of the countries in the world are suffering from corona virus, Tulsi is used as an active integrant of homemade decoction (*kadha*) and soup against corona virus. In Ayurvedic studies, Tulsi has already been mentioned as an immune booster. It has been reported to exhitbit analgesic, anti-diabetic, anti-inflammatory, antimicrobial, anti-tumour, anti-stress, anti-viral, cardioprotective, immunomodulatory, neuroprotective and rejuvenating potential. On the other hand, dried plant parts of this species are consumed in the form of herbal tea in day-to-day basis. Spices of *Ocimum* are commonly used in various dishes, soup and syrups. Basil (*Ocimum basilicum*) and Tulsi (*Ocimum sanctum*) are two most important aromatic herbs of genus *Ocimum.*

3.4. Taxonomic Classification of Basil (*Ocimum basilicum*) and Tulsi (*Ocimum sanctum*)

Figure 3 illustrates the taxanomical position of two *Ocimum* species found in India

3.5. Description of Basil (*Ocimum basilicum*) and Tulsi (*Ocimum sanctum*)

Ocimum is a perennial aromatic herb of the family Lamiaceae, also called Labiatae, and belongs to dicotyledons. Two hundred genera and about 3200 species are found in this family. The taxonomy of *Ocimum* is complex due to intersection hybridization and

multiplication of the species in the genus. It is a tropical plant which is cultivated and also grows as a weed. Generally, both the herbs may be propagated through seeds and sometime, they can grow through cutting stem (nodes) methods. The morphologic characteristics of both species exhibit natural variation and are separately discuss as follows:

Tulsi plant is an important symbol of Hindu religion and is worshipped and used in several religious ceremonies. *O. basilicum* is not just famous for its medicinal applications but also it is best known cooking basil.

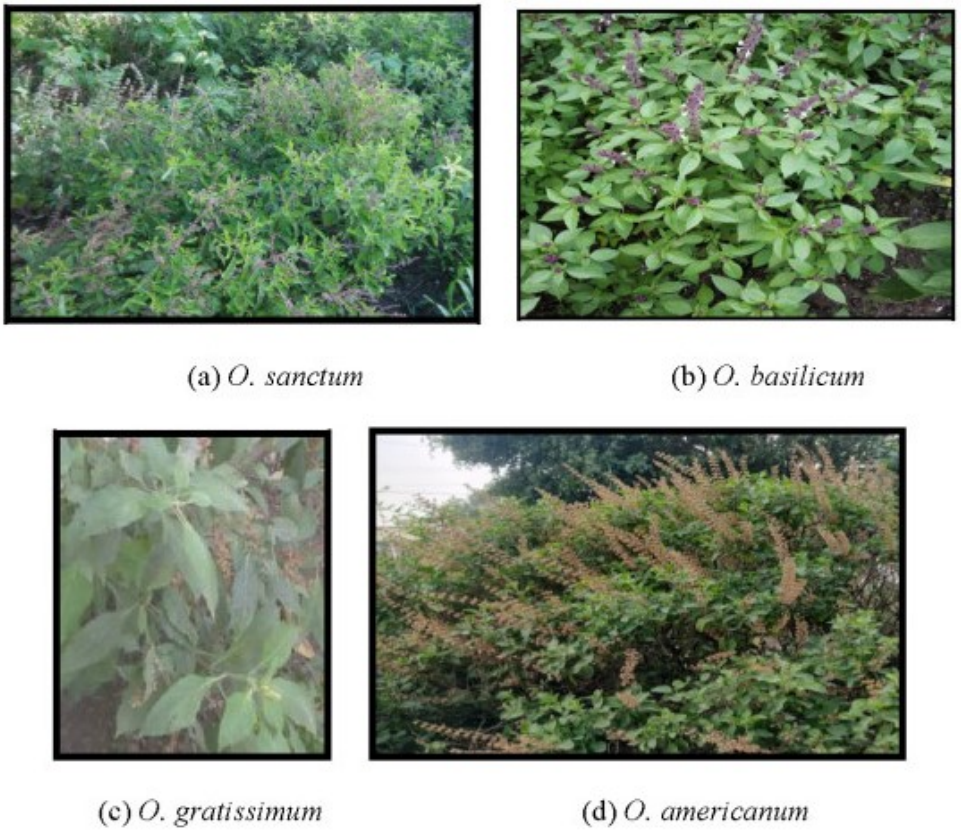

Figure 3. Tulsi (*O. sanctum* L.) and Basil (*Ocimum basilicum* L.) in the taxonomic hierarchy under Plantae

3.5.1 Physical Features

Generally, physical features of *Ocimum* species include shape, size, color and texture of leaf, stem, seeds, inflorescence, flowers and roots.

3.5.1.1 Physical Features of *Ocimum sanctum*

Vern- *Tulsi,* Sanskrit- *Ajata, Maujar, Tulsitryum,* Eng- Holy Basil

Ocimum sanctum (synonym *Ocimum tenuiflorum*), also known as tulsi plant or holy basil is erect, much branched, sparsely hairy herb with an aromatic smell. The plant is

30- 90 cm high and the roots are tap and branched. The leaves of the plant are ovate-lanceolate with an entire margin of 2.5-6.5* 1.8-3cm. The leaves are shallowly toothed, acute or obtuse hairy with minutely dots on both surfaces. The petiole is 1-2.5cm long. The inflorescence is vertillaster. The flowers of the plant are purplish- pink which is whorled in terminal with racemes 10-15cm long. The bracts are ovate, acuminate, not exceeding the calyx. The calyx of the plant is 4mm long with upper lip broadly ovate, mucronate, recurved and with a larger lower lip. The corolla is 5-8mm long with an upper lip hairy on the back with 4 lobes and the lower lip is entire, acuminate. The seeds of the plant are globose in shape having brownish black color and fruit is carcerulus. The flowering and fruiting occur in the month from April to November.

There are two commonly known varieties of *O. sanctum*: Kali Tulsi (Krishna Tulsi) with dark purple-colored leaves and Safed Tulsi (Rama Tulsi) which has green colored leaves.

3.5.1.2 Physical Features of *Ocimum basilicum*

Vern- *Marua, Murya* Hindi- *Kali Tulsi,* Sanskrit- *Veruari;* Eng- Basil.

The word *basilicum* comes from the Latin word basilisk, meaning. According to Muenscher *&* Arthur (1978), in French, it is called as "Herbe Royale", which suggests its positive nature. It is also called "The king of herbs" while its common name is Sweet Basil. *Ocimum basilicum* is an aromatic herb and shrub. The plant height is 50- 100 cm long. The stem is usually branched from the base with hairs. The leaves are petiolate, opposite, ovate- laceolate, toothed or almost whole, glabrous. with a margin of 2-7*1-3cm and either green or purple. The base of the leaves is cuneate or rounded, acute or subacute, entire or toothed with dotted glands which contain volatile oil of strong smells. The inflorescence is vertillaster. The flowers of the plant are purplish or whitish- pink in color. The whorls of the flower are simple and branched racemes with a stalked bract usually shorter than calyx and is ovate and acute. The calyx of the plant is 5-8 mm long and is hairy outside with upper lip rounded and lower lip 4- dentate. The corolla of the plant is 6-8mm long and is glabrous with pubescent smell. The fruit is an achene and the nutlets of the plant are ellipsoidal in shape with a dark brown color. The leaves of *O. basilicum* are small and liniform to large, rounded and yellow-green to grey-green, red or almost black. The flowering and fruiting occur in the month from July to December.

3.6 Distribution of Basil (*Ocimum basilicum*) and Tulsi (*Ocimum sanctum*)

Ocimum is an annual plant widely found in the tropical, subtropical and temperate parts of the world. *Ocimum sanctum* is found in tropical parts of Asia and has been growing in India for over 3,000 years. It is a grassy annual plant originated from Iran, Afghanistan and India. The plant is distributed in tropical and warm temperate regions of the world including Sri Lanka, W. Asia and Australia. It is grown throughout India up to 1800m in the Himalayas, and in Andaman and Nicobar Islands.

Ocimum basilicum found in the tropical, subtropical and temperate parts of the world and has especially established itself in Ceylon, hot West Asia, Africa, Malayan and

Pacific Islands. It is also found in tropical and hot temperate regions of India and Pakistan and also cultivated in several parts of US states. *Ocimum basilicum* is originally native to India and other regions of Asia. *Ocimum basilicum* L. includes annual and perennial herbs and shrubs from tropical and subtropical regions of Asia, Africa, Central and South America. The plant is usually cultivated near home yards rarely met as an escape, road sides or waste places.

4. Climatic Conditions for Plant Growth

Ocimum sanctum develops well in a wide range of soils. Therefore, poor laterite, rich loam, saline and alkaline to moderately acidic soil is appropriate for its cultivation. It grows in partial shade and thrives in fairly high rainfall and humid conditions. It can grow upto an altitude of 900m and is tolerant to drought and frost. This plant can be propagated through seeds.

Ocimum basilicum is well represented in warmer parts up to 1800m altitude above sea level. Plant cultivation can be done in wide range of soil type; dry loam from medium to fine loam. Well drained soil helps to encourage improved vegetative growth. Long day, high temperature and high humidity are found to be conducive to plant growth. Apart from regular cultivation methods, *Ocimum* needs well drained loamy to sandy loam soils with suitable pH ranging from 4.3-9.1. Watering in the form of shower is preferred which don't let the soil get hard. Soil must be moderately fertile. It can tolerate high concentrations of copper and zinc, but is more vulnerable to cobalt and nickel.

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