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Recent Studies on Pharmacognostical and Pharmacological Activity of *Ocimum kilimandscharicum* Guerke - A Systematic Review

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Sandeep Sood[1], Kapil Kumar Verma[1], Diksha Choudhary[1], Amit Chaudhary[1]*

[1] School of Pharmacy, Abhilashi University, Chail Chowk, Mandi, Himachal Pradesh-175028 India.

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ABSTRACT

The genus of *Ocimum* belongs to the family Labiatae and one of the most popular culinary herbs known for its medicinal properties. It includes at least 150 species and numerous cultivars. It is widely distributed in different parts of the world and has a long history of traditional medicinal uses. It is a well known plant in Indian traditional system of medicine. *Ocimum kilimandscharicum* plant is widely used in the management of various ailments including colds, coughs, abdominal pains, measles, anti-ulcer, bronchitis, anorexia, memory disorders and diarrhoea. This review delineates with all the phytochemical and pharmacological aspects of *Ocimum kilimandscharicum* that will help the various practitioners and clinicians to get aware of the modern and traditional use of this plant. This review summarizes and focused on the most interesting studies done in last five years for the various pharmacognosy and pharmacological works done on the *Ocimum kilimandscharicum* Guerke.

INTRODUCTION

Nature is the largest and best combinatorial store has delicate interest in medicinal plants. [1] *Ocimum kilimandscharicum* Gürke (Lamiaceae family) is popularly known as"Camphor Basil" or "Kapur Tulsi" [2-5] is a small perennial plant, native to Kilimandscharo hills of Africa. It is being commercialized across the globe due to the presence of camphor as the major ingredient of the essential oil present in leaves. [6] Plant is originated from the hills of *kilimandscharo* of Africa and was being named *Ocimum kilimandscharicum* confirming its confinement as East tropical countries of Africa like Kenya, Tanzania and Uganda. [7]

Ocimum Linn. belonging to the tribe Ocimeae of family Lamiaceae is a large and diversified genus of economically useful, medicinal and aromatic importance, associated with various Indian cultural traditions. It is highly valued for its therapeutic properties in traditional as well as modern pharmacological system. The main center of diversity of *Ocimum* appears to be Africa [8] with a secondary center in South America (Brazil) and Asia (India).[9] The taxonomy and nomenclature of *Ocimum* species/varieties are in a state of confusion. Various workers have reported the estimate of species not in exact numbers but approximately varying from 30 to 160 [8,9]. However, out of 333 scientific plant names of species rank, *Ocimum* has 68 accepted species names and the rest are placed as synonyms, unplaced and unassessed. India is represented by nine species of *Ocimum* (including three exotics) mainly confined to tropical and peninsular region.[10] *O. kilimandscharicum* Guerke, commonly known as camphor basil (Kapur Tulsi), is a native of Kilimanjaro, Kenya (East Africa) and then spread widely in the tropical and subtropical regions such as Rwanda, Athens, Nigeria, Ghana, Thailand and India. However, this species has a very restricted distributional area in India and was recorded earlier from wild habitats of Uttarakhand and not reported elsewhere as natural born. The wild occurrence of *O. kilimandscharicum* Guerke in the core zone of Kapilash sanctuary and other natural habitats of Odisha form a new plant record for the flora of Odisha as well as peninsular India.

Common Names

Sanskrit: Kapura Tulasi [2] **English:** African Basil, Camphor Basil, Camphor-Scented Basil, Hoary Basil, Kilimanjaro Basil, Perennial Basil, Fever plant. **German:** Kampferbasilikum **Hindi:** Kapur Tulsi, Kapuri Tulsi. **French:** Basilic Camphré, Basilic Camphre, Basilic Du Mont Kilimanjaro **Portuguese:** Basilicão-Canforado, Basilicão-Canforado (Brazil) **Russian:** Bazilik Kamforrnyi. **Thai:** Ka Phrao India (Prachin Buri), Ka Phrao Khaek (Bangkok).[11]

TAXONOMICAL CLASSIFICATION

Kingdom	Plantae
Subkingdom	Tracheobionta
Super division	Spermatophyta
Division	Magnoliophyta
Class	Magnoliopsida
Subclass	Asteridae
Order	Lamiales
Family	Lamiaceae
Genus	*Ocimum L.*
Species	*Ocimum kilimandscharicum* Guerke [8]

Figure No. 1: *Ocimum kilimandscharicum* Guerke Plant

Geographical Distribution

Ocimum kilimandscharicum Guerke is a native of Kenya (East Africa). [12] Its occurrence has been reported in Rwanda [13], Athens [14], Nigeria, Sudan [15] Ghana & India. In India it is being cultivated in U.P, West Bengal, Dehradun, Maharashtra, Mysore, Kerala, Jammu and Darjeeling. [16, 17]

Chemical Constituents

Ocimum kilimandscharicum Guerke is characterized by presence of high amount of camphor in essential oil 4. It is pale yellow in color and its content varies in different samples from 61 to 80.5%. Leaves contain the maximum amount of camphor and oil followed by flowers;

stems contain only minute quantities. It contains d-camphor, d- α- pinene, d- limonene, terpinolene and unidentified sesquiterpenes and sesquiterpenes of alcohols.[18]

Seed oil of *Ocimum kilimandscharicum* contains α – pinene (1.23%), camphene (7.32%), β – myrcene (1.58%), ethylamyl carbinol (0.88%), l – phellandrene(0.26%), α – terpinene (0.33%), p – cymene (0.62%), dl – limonene(13.56%), 1,8 –cineole (0.85%), β – ocimene (2.00%), γ – terpinene (0.88%), trans- sabinene hydrate (0.49%), α – terpinolene (1.33%), linalool (1.70%), cis – sabinene hydrate (0.47%), camphor (56.07%), 4 – terpineol (3.50%), myrtenol (1.24%), trans – caryophyllene (0.33%), germarcrene-d(0.43%).[19]

The essential oil of aerial parts of Ocimum kilimandscharicum contains α-pinene(1.23%), camphene(7.32%), β-myrcene(1.58%), α-phellandrene (0.26%), α-terpinene(0.33%), *p*-cymene(0.62%), DL-limonene (13.56%), 1,8-cineole (0.85%), β-ocimene (2.00%)γ-terpinene (0.88%), *cis*-sabinene hydrate (0.47%), α-terpinolene (1.33%), *trans*-sabinene hydrate (0.49%), linalool (1.70%), camphor (56.07%), terpinen-4-ol (3.50%), myrtenol (1.24%), *trans*-caryophyllene (0.33%), germacrene D (0.43%) as their constituents.[19]

Aqueous extract of leaves of *Ocimum kilimandscharicum* Aqueous extract of leaves of *Ocimum kilimandscharicum* contains camphor, 1,8-cineole, limonene, trans caryophyllene, camphene, 4-terpeneol, myrtenol, α-terpineol, endo-borneol, linalool.[20]

Leaves also contain flavonoids, tannins, saponins, sterols, carbohydrates, proteins and triterpenoids.[21] These chemical constituents are mainly responsible for various biological activities.

Traditional uses

This species is used in traditional medicine to treat measles, diarrhea, kidney stone, stress, cold, headache and insomnia, as well as digestive stimulant, anti-inflammatory, and analgesic agent [2-4, 22]. Leaves from *O.kilimandscharicum* (Lamiaceae Family) are used in folk medicine against articular pain [23], general pain [24], abdominal pains [25].

The plant has traditionally been used in different parts of the world for various ailments. *O. kilimandscharicum* is employed as indigenous medicine for a variety of ailments like cough, bronchitis, viral infections, foul ulcers, anorexia and wounds [10]. The leaves of *O. kilimandscharicum* are acrid, thermogenic, aromatic, insecticidal, antiviral, appetizing and deodorant and are useful in cough, bronchitis, foul ulcers and wounds, ophthalmopathy and vitiated conditions of 'vata' [26]. The plant has reported to have various central nervous system (CNS) activities. The plant has shown neurotoxic, antineuralgic, CNS stimulant, tranquilizer, anti-alzhemerian and sedative effects. [26]

Morphology

Morphologically it is a perennial aromatic evergreen undershrub with pubescent branchlets having pale green leaves which are glandular, ovate or oblong in shape, base is acute, deeply serrated, pubescent on both surfaces, oppositely arranged and about 3-7 cm in length including petioles which are 4 to 12 mm long, 1 to 2.5 cm wide; indumentums of long white ad pressed hairs or sometimes glabrous above; petiole 4-10 mm [8,27-29]. Stems are brownish green, round-quadrangular, much branched, woody with epidermis sometimes peeling off in strips below, arising from a large woody rootstock, with white glandular hairs, becoming denser in the inflorescence-axis, with sparse sessile glands.[8] The older stems tend to lose their hairs near their bases and the bark becomes shredded and conspicuous when the dry stems are broken.[27] Inflorescence is vertical, flowers are purplish white in simple or much branched racemes [28,29]; bracts usually deciduous, forming a small coma, ovate, entire, cuspidate; pedicel 3 mm, erect, slightly curved.[8]

Reported Activity

Biological activities of *O. kilimandscharicum* such as antioxidant [3,30] (, antidiarrheal [31], antiviral, and antibacterial [5, 32, 33], Analgesic and anti-inflammatory (Dos et al., 2021)[34], anticancer agent [3] have been demonstrated. The essential oil obtained from *O. kilimandscharicum* leaves (EOOK) also showed to be effective to reduce the leukocyte migration in carrageenan-induced pleurisy in mice [3. Some pharmacognostical and pharmacological activities of plant in last five years are given below.

Microscopy

The microscopic characteristics like transverse section, powder microscopy described the diagnostic characteristics which have not been explored so far. Moreover, the physical evaluation parameters include the loss on drying, pH, total ash, acid insoluble ash, sulphated ash, water soluble ash and extractive values in different solvents like petroleum ether, chloroform, ethanol and water. The nonvolatile components are found to be rich in flavonoids, tannins, carbohydrates, glycoside, terpenoid and alkaloid. The total of

26components were identified constituting 98.76% of the volatile oil comprises 84.05% oxygenated monoterpenes10.26% monoterpene hydrocarbon 4.15% sesquiterpene hydrocarbon and 0.28% oxygenated sesquiterpenes. The fingerprinting profile via HPTLC of the ethanolic extract determined 17 components at 366 nm after derivatization showing different color bands will surely help in establishing the standard validation parameters.[6]

Biosynthesis and tissue-specific partitioning

In *Ocimum kilimandscharicum*, the relative volatile composition of camphor in leaves was as high as 55%, while that of eugenol in roots was 57%. These metabolites were differentially partitioned between the aerial and root tissues. Global metabolomics revealed tissue-specific biochemical specialization, evident by the differential distribution of 2588 putative metabolites across nine tissues. Next-generation sequencing analysis indicated differential expression of 51 phenylpropanoid and 55 terpenoid pathway genes in aerial and root tissues. By integrating metabolomics with transcriptomics, the camphor biosynthesis pathway in *O. kilimandscharicum* was elucidated. In planta, bioassays revealed the role of geranyl diphosphate synthase (GPPS) and borneol dehydrogenase (BDH) in camphor biosynthesis. Further, the partitioning of camphor was attributed to tissue-specific gene expression of both the pathway entry point (GPPS) and terminal (BDH) enzyme. Unlike camphor, eugenol accumulated more in roots; however, absence of the eugenol synthase gene in roots indicated long distance transport from aerial tissues. In silico co-expression analysis indicated the potential involvement of ATP-binding cassette, multidrug and toxic compound extrusion, and sugar transporters in eugenol transport. Similar partitioning was evident across five other *Ocimum* species. Overall, our work indicates that metabolite partitioning may be a finely regulated process, which may have implications on plant growth, development, and defense.[35]

Repellence and fumigant toxicity

Essential oils of *Ocimum gratissimum* and *O. kilimandscharicum* were tested for repellence and fumigant toxicity on the adult stages under laboratory conditions. The oil of *O. gratissimum* was more repellent, but its toxicity was comparable with that of *O. kilimandscharicum*. The major constituents of *O. gratissimum* were methyl eugenol (39.5%) and eugenol (29.7%). Those of O. *kilimandscharicum* were camphor (47.1%) and 1.8-cineole (19.3%). Eugenol (LC50 of 0.24 µl/ml, 83.3%, RI50 = 0.15) and camphor (LC50 of 0.23 µl/ml, 89.5%, RI50 = 0.13) were more toxic (at 1 µl/ml for 24 h) and repellent than the other constituents. The results show potential of the essential oils for use in integrated management of the tomato pest.[36]

Polycystic ovary syndrome

Polycystic ovary syndrome (PCOS) is one of the most common causes of female infertility, affecting 5–10% of the population. Women with PCOS manifest hyperandrogenism, hyperinsulinemia, low-grade systemic inflammation, and polycystic ovaries. Unfortunately, current available medications are only symptomatic without relevant reported treatment. Therefore, a pressing need for alternative safe approaches is necessitated. To this end, the present study is designed to investigate therapeutic merits of the edible plant: *Ocimum kilimandscharicum*, in a letrozole PCOS rat model, and compare it to metformin. PCOS rats were treated with *Ok* total extract and its different fractions at 100 mg/kg orally for 10 consecutive days. Moreover, phytochemical characterization was applied using HPLC/PDA/ESI-MS to identify different secondary metabolites in the bioactive fractions. Results revealed that the total extract and ethyl acetate (EA) fraction improved insulin sensitivity and restored normal hormonal and lipid profiles as well as normal morphological structure of the reproductive system. Furthermore, elevation of SOD and reduction of VEGF levels in comparison with metformin were recorded. These results suggest that *Ocimum kilimandscharicum* extract and EA fraction halt letrozole-induced reproductive dysfunctions and restore normal morphological and physiological functions in PCOS rats, even superior to metformin. [37]

CONCLUSION

Ocimum kilimandscharicum Guerke is a native shrub and characterized by the high yield of camphor in volatile oil. Numerous traditional uses have been documented for this species. This review attempts to unite the relevant available information of the plant in last five years. Tremendous efforts have been made to validate the traditional claims of *O. kilimandscharicum* but it remains surprising that none of the studies attempts to establish the relationship of pharmacological activity with secondary metabolites except for antimicrobial activities. Hence, *Ocimum kilimandscharicum* may provide an effective natural compound(s) which can become a lead molecule(s) in drug discovery.

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