REVIEW ARTICLE

# Biomedical Description of Ocimum basilicum L.

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**ABSTRACT**

Ocimum basilicum L. is an annual plant found in the wild tropical, subtropical and temperate regions of the world. It is member of family labiatae (lamiaceae). It contains wide variety of constituents of medicinal importance. Ocimum basilicum L. is a common herb, grown in many households with a broad range of therapeutic properties. It would be a blessing in disguise if this herb becomes a medicine for the common man. Various plant parts such as leaves, seeds and roots are recommended for the common people as folk medicines. Ocimum basilicum L., has reputed medicinal uses as antioxidant, antibacterial, antimicrobial, antifungal, antiviral, cytoprotective, anticonvulsant, hypoglycaemic, hypolipidemic, hepatoprotective, renoprotective, neuroprotective, spermicidal, dermatologic and insectisidal.

## Introduction

Ocimum basilicum L. is an annual plant (Figure 1) found wild in the tropical, subtropical and temperate regions of the world, specially 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. It is indigenous in Punjab and in low hilly areas of KPK. It is also cultivated in Punjab and in lower part of Pakistan; [1,2] and its worldwide distribution is in Tropical Africa, Arabia, Pakistan, Kashmir, Himalayas to Nepal, Sri Lanka and Malaysia.[3-5] The bushy Stems grow to about two feet in height, with an upright stalk, herbaceous, branching on all sides with two leaves at every joint, a little snipped about the edges, strongly aromatic and sometime bushy. It is grown in gardens from mid to late summer.

The plant appear pubescent from the base to the upside. Leaves are opposite, glabrous, lanceolate, lanceolate-ovate or oblong, lightly toothed, shinny, with markings on veins. They are petiolate, narrow at the tips, unusually with angulate or entire-margined. The leaves have a typical aroma. Inflorescence often in terminal clusters of whorled flowers (called – Vertcilillasters). Flowers are often white, labiate (like lips), and are six in numbers, pedicel is almost sessile. Calyx 5-lobed, upper lobe expanded into a lid or cap over others, often bilabiate. Phytochemical investigation of whole Ocimum basilicum L.

plant or its specific part have been done by many research workers and a number of active constituents have been identified. These include volatile oils, saponins, coumarins, alkaloids, tannins, anthra-quinones, anthocyanins, flavonoides, diterpenoides, tri-terpenoides, pyredines, pyrolidines, polyphenols, irridoides, quinones, sugars and insect moulting hormones.[5-8] Flavones apogenin, such as luteolin and chrysoeriol were also present in several members of plant family Labiatae including O. basilicum. In addition to these compounds; 6-hydroxy and hydroxyl-flavones in glycosidic combination and lipophilic flavones; such as [5,6,4]-trihydroxy-[7,3]-dimethoxy-flavone in the members of 24 genera of this family have also been detected.6 Among coumarin; scopoletin, astol and andelicin were isolated and identified [9,10] along with 3-p-coumarylglucoside-5-monoglucoside.[11] Z. E. and E. E., isomer of enolic ester were isolated by the condensation of dopaldehyde with caffeic acid. These esters efficiently formed complexes with iron and acted as powerful fungicides.[11] Acid

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polysaccharides from the seeds of O. Adscendens[12] and Quercetin, isoquercetin, quercetin-3-0-diglucoside, rutin, kaempferol, kaempferol-3-rutinoside, caffeic acid, esculin, thymol and xantho-nucrol from the seeds of O. basilicum were also isolated and identified.[8-12] It was further investigated that the sweet taste of the seeds of O. basilicum was

**Fig. 1 Plant of Ocimum basilicum L.**

due to the presence of high concentration of trans-anethole and esragole.[10] Many members of family Labiataeproduced significant amount of essential oils. Shafiqet al. (1987)[13] isolated and identified caryophyllene, carvacrol, methyl eugenol, and eugenol, alcohols as linalool, minor amount of cineole, sesquiterpenes and d-terpene from the essential oil of O. Santum.[13] Leaves provided yellow green volatile oil which is crystalized out after some time, and called 'Basil camphor'.[14] Leaf contains volatile oil, and terpenes.[11-13] Keita et al., (2000)[14], Politeoet al., (2007)[15] and Bozinet al., (2006)[16] identified — diterpenoid; pyridine and pyrrolidine alkaloids; polyphenols and tannins; iridoids and their glycosides; quinones; furanoids; cyclitols; coumarin; sugar — like stachyose; methyl cinnamate; methyl chavicol; linalool; cineole; estragole; ocimene; borneol; sabulene; cyclohexanone; myrecenol; safrole; 1-epi-bi-cyclo-sesqui-phellandrene; ocimol; gratissimin; that was characterized as dimethyl ester of α-truxillic acid; nevadedsin; salvigenin; ursolic acid; oleanolic acid and galacturonic acid together with traces of galactose and glucose from different samples of the plant's oil.[14-16] Lee, Adam and Jirovet carried out investigations on the essential oils of O. basilicum, obtained from its seeds, leaves and other parts, either by using GLC alone, or by GLC-MS analytical techniques.[17-19] This entire work came to the conclusion that the 'Basil oil' and 'Basil camphor' contained more than 41 constituents. These researchers detected following compounds on qualitative or quantitative bases. Few of such compounds with their quantity have been outlined as follow:[17-19] α-guaiene, α-bulnescene, Eugenol, ocimene, cadinene, perillyl alcohol, Methyl chavicol, linalool, camphor, and limonene were identified from the seed oil. while methyl chavicol, linalool, and citral were identified from the leaf oil by GLC.[18-20] These researchers also isolated β-caryophyllene, germacrene-D, α-copaene, humulene, β-elemene, β-bourbonene, γ-muurolene and a sesquiterpenegratissimene from the leaf oil of O. basilicum and identified by GC-MS.[17-19] In other investigations,[19-21] the oil content of whole plant, flower and leaves, were determined, which later on, after analysis by GLC-MS, the following components were determined and identified. Eugenol, methyl eugenol, carophyllene, un-identified sesquiterpenes and terpenes. Limonene,[1-8] cineole, p-cymene, linalool, thymol, linalyl acetate and β-carophyllene were also identified. In these findings, the seeds of the plant furnished essential oil, mostly composed of phenols engenol, nerol, methyl engenol, methyl ether; carophyllene; terpinene; 4-ol-deacetaldehyde; α-selinene, α-pinene; β-pinene; camphor and carvacol.[19-21] In some plants, leaves contained the highest percentage of essential oil, whose major constituents were eugenol, carvacrol, methyl eugenol and caryophyllene.[17]-Osilicum leaves also contained ascorbic acid, carotene, calcium, phosphorus and insoluble oxalates.[17-22] Seed oil was further fractionated into polar and neutral lipids fractions. Neutral lipid afforded hydrocarbons; wax ester; tri-glycerides; free fatty acids; sterols and monoglycerides. Free fatty acid composition of the neutral lipids, as determined by GLC or GLC-MS, were caphic; lauric, myristic, palmatic, stearic acid, linoleic acid, linolenic and arachidonic acid. Fixed oil, procured from the seeds of O. basilicum was found to contain four major fatty acids i.e., palmatic acid, stearic acid, oleic acid and linoleic acid.[23] Mucilage of the seeds composed of D-Glucose; D-Galactose; D-manose; D-abrabinose; D-zylose and L-

rhamnosealong with D-galactouronic acid and D-mannuranic acid.[12] Main constituents of the oil, obtained from the flower of O. basilicum were methyl cinnamate and linalool, while the oil from both the leaves and flowers, comprised the compounds pinene, ocimene, linolene, cineole, p-cymene, terpinene, methyl heptanone, nonyl aldehyde, linalool, farnescene, borneol, gerinol and methyl cinnamate.[13,21]Hussain et al. (2008)[22]; Da-Silva et al. (2003)[23]; Muller-Riebauet al.(1997)[24] and Kofidiset al. (2006)[25] further investigated that the chemical composition and the pharmacological activities of the four seasons, effected the volatile oils of aerial parts of O. basilicum. It was further detected that the contents of most of the chemical constituents altered significantly during different seasons of the year. These workers ascertained that the hydro-distilled essential oil contents were ranged from 0.5% to 0.8%; the maximum amount was recovered in winter and minimum amount in summer. The volatile oils in this season, consisted of linalool as the abundant ingredient, that was espoused by epi-α-cadinol, α-bergamotene and γ-cadinene. These research workers further demonstrated that those samples which were accumulated during winter season, were abundant in oxygenated monoterpenes, while those samples that were collected in summer, were bacciferous in sesquiterpene hydrocarbons. These workers further determined that the biological / pharmacological activities; such as antioxidant and antimicrobial activities (which were assessed by determining the minimum inhibitory concentration (MIC) against both gram positive and gram negative bacterial strains, as well as against a number of strains of fungi.[26]

**Medicinal Uses**

Ocimum basilicum L. is a common herb, grown in many households with a wide range of therapeutic properties. It would be a blessing in disguise if this herb becomes a medicine for the common man. More clinical trials are needed to be conducted to support its medicinal and therapeutic uses. Since the basil plant (O. basilicum) is cultivated in our plane areas and as a garden ornamental plant, its various parts, particularly its leaves, seeds and roots are commonly used as daily household remedies. Various plant parts are recommended for the common people as folk medicines as exhilarants (demulcent), expectorant, antiperiodics and emmenagogues. Its leaves are often fragrant, aromatic (antiseptic) and are also used as an expectorant. Decoction of the leaves, given in gastric and hepatic disorders and is useful in catarrh, bronchitis, in cough (due to heat), acts as diuretic and emmenagogues as well as tonic for stomach. Its leaves are brushed into paste and applied over the inflammations. Its seeds are mucilaginous and demulcent, used for heat, as a household remedy when utilized in the form of syrups particularly in summer season. Seeds are also recommended as folk medicines for urino-genital complaints, such as gonorrhoea. Oil of seeds is employed in syphilis, otitis and otorrhoea, whereas the fragrant oil of basil leaves and seeds (obtained after steam distillation) is used in perfumes and toiletries. Syrup in which seeds are added become mucilaginous within minutes, which is effective against cardiac debility and palpitation. Decoction of roots is useful in malarial fever as antiperiodics. Extract of leaves is useful in earache (as drops).

**Pharmacological effects and Clinical Applications**

Followings are the pharmacological effects and clinical applications.

**Antioxidant Activity**

Ocimum basilicum L. is an important medicinal and culinary herb, that contains several highly antioxidants compounds.[15-58,22,30] Solvent extracts of O. basilicum have been demonstrated to exhibit a significant effect at cellular level, including the platelet anti-aggregate property and inhibitory action against HIV-1 reverse transcriptase.[27] In one of the patient's study with chronic bronchitis, exposure to volatile oil of O. basilicum, induced lowering of plasma levels of dienic-conjugates and ketones along with the activation of catalase in red cells, which were typical features of antioxidant actions.[28] Nitureet al. (2006)[29], further reported that the solvent extracts of O. basilicum were able to raise the O-6-methylguanine-DNA-methyltransferase (MGMT) levels.[29] Increased levels of MGMT–mRNA were capable of increasing the activity of DNA repair protein. The solvent extracts of O. basilicum were also effective for an increase in glutathione-S-transferase-pi (GSTP1) expression, but to a lesser extent than MGMT. The authors concluded that

plant constituents regulate human MGMT and probably elevated the dietary approach for fading alkylations-induced carcinogenesis.[27-30] Bravo et al. (2008),[31] further indicated a protective consequence of basil (O. basilicum) against oxidative DNA damage and mutagenesis[31], with a decreasing outcome in the cholesterol synthesis and lipid accumulation in human macro-phages by ethanolic extract.[31]

**Antibacterial Activity**

Antibacterial potentials of various parts of O. basilicum have been investigated by many authors.[16,19,32-38] O. basilicum exhibited foreboding antibacterial action against Salmonella spp., Escherichai coli, Campylobacter jejunii and Clostridium perferingens.[32] Similarly, Opalchenova and Obreshkova (2003)[33] indicated that the volatile oil procured from the aerial parts of O. basilicum also demonstrated a marked action against drug immune clinical isolates from different species of Staphylococcus, Enterococcus, and Pseudomonas genera[34] Minimum inhibitory concentrations (MICs) between 0.0030% and 0.0007% (v/v) were described by these authors.[33] Antibacterial activities of various parts and essential oil of O. basilicum have also been ascertained by many other research workers including— Tomaret al. (2010) [34], Gupta et al. (2009)[35], Tomoko et al. (2002)[36], Durgaet al. (2010)[37] and Ahmet et al. (2005).[38]

**Antimicrobial Activity**

Different plant parts of basil (O. basilicum) have been exploited for its antimicrobial effects in the laboratory experimental studies and concluded with significant results.[22,34,38,39,40] In India, basil is used for dental ailments due to its proposed antimicrobial effects but the mechanism of its action is not clear. Research workers found that the essential oils extracted from different plant parts, particularly the leaves and seeds of different species of genus Ocimum inhibited the growth of wide range of bacteria and other microbes.[22,38-40,42-45] They further investigated that the whole samples of essential oil, as well as its individual phytochemical constituents proved to have strong curbing properties in vitro and in vivo, in relation to the microbes of various diseases and to infection in animals and in human beings.[22,34,38-40,42,45] Both organic solvent and water extracts of various plant parts of O. basilicum and basil oil are helpful in treating many serious systemic diseases, as well as the localized infections.[22,34,38-40,42-45]

**Antifungal Activity**

Many infections of skin, hair, nail, and subcutaneous tissues, in animals and human beings, are induced by several organisms, mainly different species of fungi. These organism were named dermatophytes and the crusade diseases were called dermatophytoses.[46,47,48] A number of dermatophytes had been separated from animals by many workers[49,50] Use of synthetic antifungal drugs is restrained to treat human or animal due to their high perniciousness.[51] Few of the antifungal agents, from plants and their natural products are at liberty and licensed for employing in the veterinary practice or for human being treatment in various countries of the world. It is said that most of the antifungal plant products are quite safe for the human as well as for animal consumption.[51]Antifungal effectiveness of the solvent extracts of aerial parts, root extracts, basil oil and the isolated phytochemical compounds of O. basilicum were investigated by many authors and compared with the standard antiseptics.[52-58] In some of the findings, it was concluded that the minimum inhibitory concentration (MIC) of the solvent extracts of aerial parts, root extracts, basil oil and their isolated phytochemical compounds, when compared with that of the standard antiseptics, showed that higher concentrations are needed to inhibit the growth of wide ranges of test organisms.[52-58] Further, it was demonstrated that the ethanol extract of aerial parts of the plant and its isolated phytochemical compounds, showed higher degree of antifungal activities than the root extracts, thus suggesting that the antifungal agents were most probably polar in nature.[48-56] The essential oils also showed significant antifungal activity against many plant pathogenic fungi.[52]

**Antiviral Activity**

Many research workers have conducted various laboratory experimental studies for investigating the demeanour of basil (O. basilicum) for its antiviral activities. Nevertheless, each of the study indicated different compounds, responsible for its antiviral effects. In vitro studies of various plant parts of O. basilicum, exhibited substantial inhibitory actions against HIV-1 induced cytopathogenicity in MT-4 cells.[57]The active factors present in the solvent extracted samples were found to be water-soluble

polar substances. Furthermore, other than aqueous extracts, inhabitation of giant cell formation in co-culture of Molt-4 cells with and without HIV-1 infection, also demonstrated inhibitory activity against HIV-1 reverse transcriptase.[57] In another laboratory experimental studies, Chiang et al. (2005), demonstrated that both the aqueous and ethanolic extracts of O. basilicum aerial parts, along with its phytochemical compounds, like apigenin, linalool, and ursolicacid, revealed a wide ranges of antiviral activity.[58] These authors further ascertained that — Ursolic acid displayed a pronounced action against herpes-viruses(EC50=6.6mg/L., selectivity index (SI)=15.2);adeno-viruses (EC50=4.2mg/L., SI=23.8); coxsackie-virus-B1 (EC50=0.4mg/L; SI=251.3); and entero-virus-71 (EC50=0.5mg/L., SI=201). Apigenin possessed the highest activity against herpes-viruses (EC50=9.7mg/L., SI=6.2); adeno-viruses (EC50=11.1mg/L., SI=5.4); hepatitis-B-surface antigen (EC50=7.1mg/L., SI=2.3); and hepatitis-B-e-antigen (EC50=12.8mg/L., SI=1.3) and Linalool pointed out the potent activity against AVD-II (EC50=16.9mg/L., SI=10.5).57No activeness was noted by these research workers, for carvone, cineole, β-caryophyllene, farnesol, fenchone, geraniol, β-myrcene, and α-thujone.[57] They also found that the antiviral action of these compounds against CVB1 and EV71 was to take place during the initial infection levels and at the replication phase.[58,59]

**CytoprotectiveEffects**

Renzulliet al. (2004)[60] demonstrated that Rosmarinic acid is a natural phenolic compound, which is probably present in many herbs of the family Labiatae (Lamiaceae). This compound is also present in O. basilicum, which is said to inhibit the complement-dependent inflammatory processes.[60]In vitro studies showed that rosmarinic acid was able to cut down oxygen species production, protein and DNA synthesis inhibition, which were induced by two types of mycotoxins. The cell death was thus prevented. It was established by the reduction of DNA fragmentation and also by the inhibition of caspase-3 activation.[60] Manosroiet al. (2006)[61] also carried out an investigation that the anti-proliferative activity of O. basilicum essential oil on KB and P388 cell lines. They concluded that O. basilicum oil had an IC50 value of 0.0362mg/mL (12.7 times less powerful than 5-FU) in P388 cell lines.[61]

**Anticonvulsant Activity**

In one of the reports of WHO, it was observed that about 450 million people in the entire world have endured mental, neurological, or behavioural problems at some time in their life.[62] Large-scale research on plants, their active photochemical compounds and their derivatives have taken place in recent years that could furnish some new alternative treatments and therapeutic uses, for various diseases of central nervous system (CNS) in human beings. Epilepsy (a neurological disorder marked by sudden recurrent episodes of sensory disturbance, loss of consciousness, or convulsions, associated with abnormal electrical activity in the brain) is a group of disorders, delimited by repeated self-generated attacks that manifested from complex processes, implying various neurotransmitter systems such the glutamatergic, cholinergic, and gabaergic system. The estimation of the prevalence rate for epilepsy according to WHO is about 1–2% of the world population.[62,63] Although a number of classic and more modern anticonvulsant drugs are available for the treatment of epilepsy patients worldwide, the seizures remained uncontrolled in more than 20% of the cases. Moreover, nearly all the existing anti-epileptic drugs, — such as hydantoins, deoxybarbiturates, succinimides, benzodiazepines, iminostilbenes and carboxylic acids, were obtained through chemical synthesis.[62,63]

On the other hand, many species of aromatic plants are medicinally used, due to the occurrence of essential oils and phytochemical compounds; some of them possessed certain CNS properties, including anti-epileptic action with history of usage in folk medicines. Recent studies on essential oils and their main phytochemical compounds have drawn the attention of many scientists for screening the natural products for such purposes and study their chemical and pharmacological aspects, which might potentially extend further, for the development of new anti-convulsant compounds having advantages over current synthetic drugs.[64] For this purpose, the basil oil and its phytochemical compounds, obtained from the leaves and seed of O. basilicum were used by many research workers.[62] Almeida et al. (2003)[64], demonstrated that the O. basilicum essential oil, at higher doses, produced substantial increased in a

dose dependent reaction time of convulsion and the percentage of mice displaying clonic seizures[65] It also reduced lethal effects in response to different stimulants of convulsions used in this study.[64,65] It was further indicated that the essential oil increased the latent period for growing of paroxysms in pentylenetetrazol and PIC tests.[65] For pentyl-enetetrazol, the effects of essential oil were reversed by flumazenil. Moreover, it was also observed by these workers that the essential oil did not intervene with the convulsions induced by strychnine.[64-66] Oliveira et al. (2009)[67] isolated a number of phytochemical compounds from the O. basilicum essential oil and pointed out that 1.8-Cineole, linalool, and geraniol were the main constituents, comprising about 92.9% of the total oil. These compounds were obligated for blocking the clonic seizures produced by pentylenetetrazole, picrotoxin or strychnine in mice.[67,68]

**Hypoglycaemic and HypolipidemicEffects**

Recently, Mohan et al. (2011)[69] and Hussain et al. (2001)[70] indicated the hypoglycemic and hypolipidemic effects of aqueous extracts of various parts of both O. sanctum and O. basilicum, when studied on rats. They found substantial reduction in blood glucose, serum lipidprofile, lipid peroxidation products, and also improvement in the glucose tolerance.[69,70] The aqueous extract also reduced LPO formation, thiobarbituric acid reactive substances (TBARS) and increased antioxidant enzymes such as superoxide dismutase (SOD), catalase (CAT), glutathione peroxidase (GPX) and glutathione transferases (GT).[69,70]

**Hepato-protective, Reno-protective and Neuro-protective Activities**

Chattopadhayet al. (1992)[71]; Muglikaret al. (2004)[72] and Sarkar et al.(1990)[73] carried out a contingent investigation of the hepatoprotective, reno-protective and neuroprotective activities of the aqueous leaf and seed extracts of other important species of Ocimum. They found that the leaf extract of O. sanctum was hepato-protective against hepatotoxic paracetamol, by significantly reducing the serum enzymes — aspartate aminotransferase (AST), alanine aminotransferase (ALT), alkaline phosphatase (ALP) in rats and also showed marked reduction in fatty degeneration of liver on histo-pathological examination.[71] It was further ascertained that the administration of combination of O. sanctum aqueous leaf extract and gentamicin, significantly prevented rise in levels of serum creatinine and blood urea when compared to the gentamicin alone treated group in rats.[72] Aqueous leaf and seed extracts of O. sanctum plant have also been described to cut down the blood and urinary uric acid level in albino rabbits and also exhibited diuretic property.[73] Rodrigues et al. (2001)[74] also found that the aqueous leaf extract of O. sanctum prevents stress induced dendritic deficiency in hippocampal neurons in albino rats. All these researches indicated that the extracts of various parts of both O. basilicum and O. sanctum had a very high safety margin and very low toxic profile, providing safe beneficial effects at low doses without any undesirable side effects.[69-74]

**Spermicidal Effects**

Buchet al. (1988)[75], studied the effects of extracts of leaves and seeds of basil (O. basilicum) on human spermatozoa in vitro. They concluded that the basil plant had potent spermicidal action.[75]

**Dermatologic Effects**

Balambalet al. (1985)[76] studied the effects of extracts of various plant parts of basil (Ocimum basilicum L.) in humans, against acne vulgaris. They concluded that these extracts were quite effective in acne vulgaris, but the mechanism of their action was not clear.[76]

**Insecticidal Effects**

Erleret al. (2006) [77] studied the mosquito repellent activities of five essential oils, including the 'basil oil'. Since Culexpipiens was very common pest mosquito in most of the urban and suburban regions; they used mosquito species — Culexpipiens for such purposes and found that this oil was very effective to repel these mosquitos.[72]

## Conclusion

Ocimum basilicum L., has reputed medicinal uses as antioxidant, antibacterial, antimicrobial, antifungal, antiviral, cytoprotective, anticonvulsant, hypoglycaemic, hypolipidemic, hepatoprotective, renoprotective, neuroprotective, spermicidal, dermatologic and insectisidal.[77]

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