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Review Article

**PHYTOCHEMICAL CONSTITUENTS, PHARMACOLOGICAL
AND TRADITIONAL USES OF *OCIMUM GRATISSIMUM L* IN
TROPICS**

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India- 486003**Abstract:**

Ocimum gratissimum L is a popular medicinal plant with a wide therapeutic potential. The chemical compounds derived from the plant and leave contain essential oil with various pharmacological applications. The plant is generally antimicrobial, antidiabetic, antidiarrheal, antiurolithiatic antioxidant antimutagenic, insecticidal and anti cancerous in nature. The plant likewise consumes as a dietary supplement and flavoring agent in various subtropical and tropical and even warm temperate countries. The whole plant mainly the leaves or even seed have various ethnomedicinal properties. This comprehensive review focuses on chemical composition, ecological adaptation, pharmacological, nutritional and ethnobotanical importance of the plant to explore numerous therapeutic applications.

Keywords: *Ocimum gratissimum*, phytochemical constituents, pharmacology, ethnobotany

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INTRODUCTION:

Plants contain valuable information in the form of medicinal knowledge that has to be preserved in sake of modern health care system [1]. The ancient literature on traditional health care should be evaluated in all perspective, starting from identification, cultivation, applications along with sustainable use and conservation [2]. In total 452 vascular plant families with 1730 species, are registered with medicinal uses. Therefore, special focus should be provided on the genetic makeup, chemical composition, morphology, physiology of a species to extract its potential as therapeutic value [3,4].

Ocimum gratissimum L is commonly known as clove basil or lemon basil, a polymorphic branched, aromatic shrub nearly 0.5 to 3 m tall [5] belonging to family Lamiaceae, has been identified as a culinary herb with wide applications. The plant is mainly distributed in tropical regions and native to South Asia, Africa and various regions of South America [6] Polynesia, Bismarck, Archipelago and the West Indies. This perennial pantropical grass, a weed (Fig. 1) which is woody at its base and generally prefers open locations and disturbed land like roadsides and clearings [7], wet and fertile conditions and even tolerate drought after flowering [8]. In some regions of South-East Asia the plant exists up to about 300 m altitude and grown as a hedge plant. In countries like India, Vietnam, Thailand, the species is exotic hence sometimes need biosafety procedures [7]. The genus *Ocimum* contains 160 species worldwide with India accounting nine species [9] and in Northern India the tribe Ocimeae is very popular [6]. The shrubs have been used for various purposes, and leaves are of more significance, however whole plant or even seed also has ethno-pharmacological importance as they

yield essential oil of economic importance. This review focuses on the chemical composition, ecological adaptation, therapeutic and various other important applications of the shrub in the tropics.

CHEMICAL COMPOSITION

The phytochemical study of the plant shows the presence of several bioactive compounds. The aqueous leaf extract assay shows the presence of steroids, tannins, flavonoids, saponins, terpenoids alkaloids, inulins, phenolic compounds, B-carotene, glycosides [10-18] carotenoids, reducing sugars, phlobatannins, anthraquinones and cardiac glycosides [14] with steroidal ring and deoxy-sugar [12]. Beside these polyphenols, quinones, coumarins, and catechins [17] were also detected in aqueous extract.

The methanolic leaf extract shows the presence of flavonoids, alkaloids, tannins, terpenoids, phlobatannins and cardiac glycosides with steroidal ring [12, 19]. The spectrophotometry also confirms the presence of high phenolic and flavonoid compound in the methanol leaf extracts [20]. The ethanolic extract contains alkaloids, steroids, tannins, flavonoids, phlobatannins terpenoids [21]. The thin-layer chromatography yields an unidentified polar compound containing carbon, hydrogen, oxygen and nitrogen [22] from the plant leaves. Phytochemical screening of ethanol extract of the aerial part of the plant shows the presence of phenolic compounds, terpenoids, saponins, carbohydrates, anthraquinones and sterols. The research has also confirmed the presence of sterols and phenolic compounds in the hexane chloroform fraction and methanol fraction [23] with young leaves possessing the highest phenol content and petroleum ether extract of mature leaves the highest flavonoid [14].



Fig. 1 *Ocimum gratissimum*

The analysis of the whole plant fraction shows the presence of essential oil thymol, thymol p-cymene, γ -terpene, t-sabiene hydrate, β -phellandrene, limonene, eugenol, eugenol spathulenol, geraniol, eugenol γ -muurolene, 1,8-cineole, gratissimol, germacrene-D and β -caryophyllene and external flavones mainly xantomicro and cirsimaritin [24-31]. Beside these plant leaves also contain beta-selinene and other essential oil like sesquiterpenes and monoterpenes hydrocarbons, oxygenated and other components [28].

The essential oil extracted from the fresh leaves contain eugenol, citral, ethyl cinnamate, linalool, methyl eugenol, pinene, camphor, cis-ocimene, trans-ocimene, trans-caryophyllene, germacrene-D, farnesene and l-bisabolene, thymol, bisabolone, oleanolic acid, along with the volatile oil, limonene, terpinolene γ -terpinene, p-cymene, and 1,8-cineole [32-36]. Similarly, dried leaves also contain bioactive compounds like saponins, alkaloid, flavonoids, phenolics and terpenoids [37]. The plant seed mucilage contains pentoses, hexoses, uronic acid, lipids [38] and essential oil thymol and eugenol [39].

ECOLOGICAL ADAPTATIONS

In some countries, the shrub is planted as a hedge [5]. The plant can be used as the best supplement for farm crops during the famine as it can grow in almost all types of soil, even they are nutritionally poor, and shows wide adaptability [40]. Under water stress condition, the mineral like nitrogen shows increase in content which might be due to the mobilization of mineral to the leaves helping in the synthesis of amino acids and proteins to resist water stress [41]. Further, the reduction in the potassium and calcium was also noted which might be due to the mobilization of these elements to the roots, helping as osmo-protectants, and the breakdown of ascorbic acid to resist drought [41]. The field experiment in different combinations (daily watering+sunlight, five days watering+sunlight, daily watering+natural shade, five days watering+ natural shade) shows a decrease in plant height and total leaf area under water stress, increase in essential oil content under water stress and shade, and reduction in oil content in full sunlight conditions [42].

The study has also confirmed that the plant possesses UV-B tolerance capacity, which results in an increase in flavonoid, ascorbate, and proline contents without influencing the antioxidant properties of the leaves [43]. The pot experiment proves that under water stress condition the leaf composition shows decrease in saponin, increase in tannin whereas flavonoid content remains unchanged [41]. Similarly, carbohydrate, moisture content, dry matter and crude

fat decreases and the ash, crude protein and crude fiber content increases and calorific value of the leaves remain unchanged in the same condition [44]. The water stressed and arbuscular mycorrhizae fungi (AMF) treated plant shows increase in oil content and chlorophyll pigments and total phenolic compounds and proline content increases only under water stress condition [45].

PHARMACOLOGICAL USES

The *Ocimum gratissimum* potentiality as an antibacterial and antifungal agents has been provided in numerous studies [1,46]. The pharmacological testing of aqueous extracts of the plant shows inhibition of the jejunum spontaneous pendular movement in rabbit, non-competitive stomach strip blocking in rat and non-toxic analgesic effects in mice [47]. Plant oil possesses etiologic properties a potentiality to inhibit the virulent strains of *Shigella* isolates, the causal organism of diarrhea and also reduces extracellular protease activity, o-lipopolysaccharide rhamnose content, and incidence of kerato conjunctivitis in guinea pigs [39].

The methanolic leaf extracts can be a novel therapeutic agent against nicotine toxicity as it decreases lipid-protein damage, free radical generation, and antioxidant status in male mice in murine peritoneal macrophages in vitro [20]. The hexane fraction exhibited the highest antimicrobial activity against *Vibrio cholera* and *Klebsiella pneumonia* and also possesses the highest grain protectant activity [48]. The ethanolic leaves extract exhibits antimicrobial activity against *S. typhi*, *N. gonorrhoeae*, *K. pneumoniae*, *P. aeruginosa*, and *V. cholera* [23] and along with ampicillin it becomes synergistic showing antibacterial properties against *Escherichia coli* and *Proteus mirabilis* and similarly synergistic with nystatin and ketoconazole showing antifungal properties against *Candida albicans* isolates [49]. The disc diffusion and tube dilution methods confirm the anti-diarrheal activities of leaf extracts against the bacteria *Escherichia coli*, *Salmonella typhi*, *Plesiomonas shigelloides*, *Aeromonas sobria* and *Shigella dysenteriae* [50]. The chloroform leaf extract shows better efficacy against filariasis causing mosquito vector *Culex quinquefasciatus* [51].

The researches on plant leaf flavonoid confirms broad-spectrum anti-bacterial activity against *Staphylococcus aureus*, *E. coli* and *Proteus mirabilis* [19]. The aqueous leaf extract shows hypoglycaemic effects reducing lipid level malondialdehyde, triacylglycerol and LDL-cholesterol [18] and the plasma glucose level in streptozotocin impelled

diabetic rats [52] and also inhibit CCl₄-impelled liver injuries in rats [53] thus with a possibility to combat diseases in man. The fresh aqueous leaf extracts inhibit chemotaxis, proliferation, 3D growth and morphogenesis and induction of COX-2 protein and reduce tumor size in breast cancer cells [54] whereas dichloromethane leaf extract can inhibit myeloid leukemia [55] in vitro, thus with a potential to combat cancer in human beings.

Various researches conducted with an aqueous leaf extract on rat for hematological parameters show a distinct variation. In Central and West Africa the plant has been used in therapeutic and culinary applications and dose and time-related methanolic crude leaf extract shows haematinic and haemopoietic potentiality with a decrease in RBC and the increase in WBC count when tested for phenylhydrazine-induced anemia in Albino wistar rats [56]. Some studies observed increase in the level of RBC, hemoglobin (Hb) packed cell volume (PCV), neutrophils and platelet count, along with platelet indices like mean platelet volume (MPV), platelet distribution width (PDW) and platelet-large cell ratio (P-LCR) [57], whereas other studies observed decrease in these parameters [58]. The study of the dose-and time-dependent effect of aqueous leaf extract on some biochemical parameters has shown significant impact with reduction in the serum levels of urea and total protein, hemoglobin, PCV and neutrophils and increase in total acid, uric acid, prostatic acid, phosphatases, white blood cells and lymphocytes [59]. The thiobarbituric acid assay of liver and muscle systems of ovarian models reveals that the exposure of plant leaves to UV-B shows a slight change in lipid peroxidation however the free radical content increases [60].

The presence of eugenol as a chief constituent of essential oil in the leaves shows fungistatic at minimum and fungicidal at high concentration against *C. capsici*, *A. alternata*, and *S. rolfisii* pathogens of betelvine, thus making it an important indigenous and biodegradable agent to combat fungal pathogens [43]. The hexane fractions of the ethanol extract of the aerial part of the plant also possess grain protectant properties [23].

NUTRITIONAL AND FLAVOURING PROPERTIES

O. gratissimum is used as a spice and possesses nutritive value and flavouring properties. The studies have proved that it contains protein, fiber, lipid, carbohydrate [11,13,16,61,62], ascorbic acid [13,16,17], vitamin E [16,17] food energy [11,61] and some amount of moisture [13,16,62] and ash

[16,63] along with minerals like calcium, potassium, iron, phosphorus, zinc, magnesium, sodium, and nitrogen [11, 13, 61,62].

The mature leaves possess higher nutritive value (370.16 cal per 100 gm) compare to fresh leaves [14]. In Africa, the plant is used as a vegetable and a good source of vitamin and protein [16] and is used in cooking processes and consumed with kernels of *Citrullus lanatus* [63]. In western Africa, the plant is used as a supplementary feed for cattle [13]. In Nigeria and Cameroon the plants are consumed as vegetables [19,64,65]. The leaves are edible and used to prepare soup and tea [17]. In Sumatra island, the leaves are used as a tea, whereas in other parts they are applied in washing of human dead bodies [7]. The leaves are also used as a flavouring agent [7, 63,66].

The in vitro studies has confirmed that ethanol and the dichloromethane leaf extract possess free radical scavenging properties [55], whereas methanol leaf extract exhibit antioxidant potential against scavenging 2,2-diphenyl-1-picrylhydrazyl (DPPH.), superoxide anion, OH, nitric oxide radicals and inhibiting lipid peroxidation, thus preventing deterioration and improving food quality [67]. The plant has wide application in perfumery industry [68] and also possesses fungi toxic and self life enhancer characteristics and thus one of the best food preservative agents [69]. Some study suggests that the use of plant material as a food spice has no impact on the effectiveness of conventional antibiotics, which are consumed with it as a practice of traditional medicine in various countries in the world [70].

TRADITIONAL USES

The plant has a wide application in the traditional system of medicine to cure various ailments. The plant produces essential oil with antibiotic [7] antioxidant [18], antimalarial [26], antifungal [33,35,71], antibacterial [9,27,29,33,64], antidiarrheal [49], antidiabetic [52], anti-carcinogenic [54], insecticidal [21,69], antimutagenic [65] and antiurolithiatic [72] properties. Studies have proved that dry leaves have better disease preventive properties in comparison to fresh leaves [37].

In Africa, the plant has traditional importance as condiments and for treating various diseases such as pyorrhea, bronchitis and dysentery [73] and dried leaves are used in treating headache and fever [74]. Igala community of Kogi State, Nigeria uses leaves and root in treating diabetes, gastrointestinal problems and gonorrhoea [75] and in Abia State leaf juice are used to treat malaria fever [76]. In South-

West Nigeria plant leaves are used in sexually transmitted infections [77] whereas in some regions the water and ethanol extracts of the plant are used for several microbial and non-microbial associated diseases [78]. In some other parts of Nigeria the plant is rare with strong antifungal potentiality and traditional medicine practitioners utilizes leaf extract in treating skin related diseases like Eczema [79]. In Sao Tomé and Príncipe islands in central Africa the plant is used as traditional medicine as febrifuge and treating, respiratory disorders [80]. In Nigeria the plant leaves macerates are used in treating diarrhea and respiratory disorders [23]. In Brazil several species of the genus *Ocimum* including *O. gratissimum* have been used as a traditional medicine in treating coughs, bronchitis, sore throat, and also in food and flavoring agent and crop improvement programme [81].

In South Asia, the whole plant is used in treating sunstroke, headache, stomach and influenza and seed are used against gonorrhoea [3]. In northwest Africa, the traditional practitioners use the plant as insect repellent [82]. In South Africa, women use the plant to prevent dystocia and after childbirth to eliminate blood clots [63]. Crushed leaves are utilized to stop bleeding of fresh wounds [48,63,83] and aqueous extract are hepatoprotective [53]. The ethanolic extract of the leaves is used for the treatment of several ailments such as skin, urinary tract, and gastrointestinal infections [48]. The plants are also used in treating dystocia, vomiting, dysmenorrhoea, mycoses, digestive troubles, cough, haemorrhoids, dysentery, abscess, typhoid fever.

In India, the plant has a wide folklore medicinal importance and is used in treating diarrhea, headache, fever, pneumonia [84]. In some regions in Maharashtra, the leaf juice is used as an antidote during snake bite [85]. In central India the seed extract mixed with sugar water is given during hot summer days as a nerve tonic [86] and leaf extract are applied in cuts to stop bleedings [87]. In northern India plant is grown for culinary, essential oil, perfume for herbal toiletries, flavouring agent and aromatherapy treatment [6]. The essential oil obtained from the plant is used to treat ears or eye disorder, stomach, fever, diarrhea, throat inflammations, and skin diseases [7]. In Central India, the local community of Bundelkhand region applies leaf decoction on cattle skin to treat ectoparasites [88]. In Barack valley, Assam the Manipuri community uses plant leaf with honey to treat fever [89]. In Tripura, the plant leaf along with Zinger is utilized for the treatment of fever,

headache, diarrhea, eye problems, upper respiratory tract disorders and skin diseases [90].

Fresh leaf juice is administered during indigestion and the decoction of boiled leaves of *O. gratissimum* and *Phaseolus lunatus* is used to treat stomach disorders in children in some eastern Imphal villages in Manipur [91]. The Yanadi Tribe of Eastern Ghat in Andhra Pradesh uses the whole plant juice to treat cough and cold [92]. The Nancowry community of Nicobar Islands utilizes the plant orally in breathing disorders [93] and in some parts of Odisha the plant leaves are used in treating rheumatism [94].

CONCLUSION

It can be concluded that *O. gratissimum* is an important plant with a potential in pharma industries in clinical tests and preparation of new herbal formulation to cure human diseases. The plant has traditional uses and in many parts of the world, it is edible and used as a nutritional and flavouring agent. As the access towards naturopathy has increased globally and a large number of researches are under process to introduce innovative natural products, hence this plant is a serious candidate in studying and discovering novel bioactive compounds and their use in treating incurable diseases.

CONFLICT OF INTEREST: None

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