A comprehensive review on nutritive value, phytochemicals, and pharmacological activities of *Ocimum basilicum* var. *thyrsiflora*

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**ABSTRACT**

The genus *Ocimum* has many species belonging to the Lamiaceae family that are used to treat various diseases and disorders. *Ocimum basilicum* has been found to contain over 200 chemical components in different plant parts. The bioactive components showed the presence of α-linalool, camphor, limonene, thymol, citral, β-linalool, estragole, etc. *O. basilicum* exhibits anti-inflammatory, antioxidant, antiulcer, antiviral, hypoglycemic, hypolipidemic, antimicrobial, anticancer, wound-healing activities, etc. They have also been used to treat fevers, digestive issues, stomach cramps, nausea, gastritis, migraine, diarrhea. This review aims to provide information about the chemical compounds and biological activities of *O. basilicum* var. *thyrsiflora* (Thai basil). To the best of our knowledge, this is the first review outlining the innovative ethnomedicinal approach to oral health care that, through its strong phytoconstituents, has the potential to improve modern medicine.

**Implication for health policy/practice/education/research/medical education:**
The findings revealed the presence of vitamins, protein, minerals, electrolytes, phytonutrients, and secondary metabolites such as flavonoids, phenolic compounds, etc. Essential oils and extracts have exhibited various pharmacological activities such as antifungal, antibacterial, antiviral, antioxidant, anti-inflammatory, antioxidant, antiulcer, anti-dyspepsia, antimicrobial, anticancer, wound-healing activities, etc. They have also been used to treat fevers, digestive issues, stomach cramps, nausea, gastritis, migraine, diarrhea. This review aims to provide information about the chemical compounds and biological activities of *O. basilicum* var. *thyrsiflora*. To the best of our knowledge, this is the first review outlining the innovative ethnomedicinal approach to oral health care that, through its strong phytoconstituents, has the potential to improve modern medicine.

**Introduction**

For thousands of years, medicinal plants have been used for a wide range of prospects, including preserving food, pharmaceuticals, natural remedies, and alternative medicine. Compounds produced naturally instead of artificially are frequently assumed to biodegrade more easily and hence be more eco-friendly. Nowadays natural antimicrobial, antioxidants, cytotoxic, and nutrient agents have risen in popularity, and their use and good perception by consumers are increasing. In recent years, multiple drug resistance to pathogenic microbes have emerged in humans and plants, as a result of the widespread usage of commercial antimicrobial medicines used to treat infectious diseases (1).

Scientists have become increasingly interested in plant study, particularly in developed countries such as Europe and America. Approximately 60% of the world’s population is estimated to depend on herbs and natural products for treatment, making it an integral source of pharmaceuticals (2).

The study of a wide spectrum of organic compounds that have been produced in plants is known as phytochemistry. Phytochemistry also determines the natural distribution, structure, biosynthesis, metabolism, and physiological
activities of these compounds (3). Aromatic plants have a unique combination of volatile compounds characterized by sesquiterpenes and monosesquiterpenes, which play a key role in flavouring, fragrance and perfumery. In addition, they are distinguished by the existence of phenolic compounds, mainly phenylpropanoids and coumarins, in addition to essential oils (4). After the discovery of certain commercial synthetic antioxidants to be mutagenic, toxic, and carcinogenic, researchers have become more concerned about secondary biomolecules. Because of their antioxidant and antiradical properties, several plant species, including aromatic plants, have been studied (5-10).

A wide spectrum of climatic conditions and soil types are required for the good growth of the genus Ocimum. For example, saline and alkaline soils, moderately acidic pH, moderate to heavy rainfall, normal humidity, and high temperatures. It is most popular in China, Japan, Turkey, Iran and also found in South and Central America, tropical Asia, and Africa (11). The genus Ocimum is particularly well-known for its antioxidant properties (12).

Ocimum basilicum is a valuable medicinal plant as well as a culinary herb in medicine. It has long been used to treat anxiety, cough, common cold, headaches, fevers, diabetes, migraine, and neuropathic problems. It is also used for heart problems, inflammatory diseases, depression, gastrointestinal diseases, insect bites, cramps, sinususes, and several neurological diseases (13). Moreover, the plant’s flowering tops and leaves are apparent as a galactagogue, carminative, stomachic, and anti-inflammatory remedies in traditional medicine (14). In Vietnam, fever and malaria are cured by O. basilicum. Mucilaginous seed is used in medicine and in production of non-alcoholic beverages. The essential oil is used to control insects such as flies and bugs. Purple leaf ornamentals are fashionable and are most aromatic as green leaf varieties and can be utilized in the same way (15).

Ocimum basilicum is well recognized for its essential oil, which is accountable for the fragrance, aroma and condiment flavour (13). The plant also contains steroidal glycosides, cinnamic acid ester, acetylated and glycosylated anthocyanins, triterpenoids, tannins, flavonoids, phenolic acids, for example, hydroxybenzoic acid, chicoric acid, p-coumaric acid, caffeic acid, protocatechuic acid, rosmarinic acid, vanillic acid, syringic acid, ferulic acid, and lithospermic acid B (16,17). Sweet basil oil has a significant commercial value because of the occurrence of phenylpropanoids such as chavicol, eugenol, and terpenoids (18).

According to pharmacological studies, several O. basilicum extracts contain antimicrobials, antioxidants (13), as well as antiviral (19), anti-inflammatory, hypolipidemic (20), anti-platelet aggregation, anti-carcinogenic, antiulcerogenic, and antithrombotic (21) properties. It also reduces LDL-cholesterol levels while increasing HDL-cholesterol levels in the blood, hence preventing cardiovascular disorders (22,23). Phenolic compounds’ antioxidant properties are mostly related to their redox activities, which have the ability to absorb and neutralize free radicals, quench singlet and triplet oxygen molecules, and degrade peroxides. The antioxidant properties of most of these phytochemicals have been linked to lower cancer mortality rates in a diversity of human populations (24).

Extracts of O. basilicum (basil) from the roots, stems, flowers, leaves, and seeds have been used in a variety of medical treatments. Recent research has discovered that sweet basil extracts contain antibacterial effects against Escherichia coli and Staphylococcus aureus, antifungal effects against Rhizopus solani and Aspergillus niger, and antiviral effects against a few strains (25,26). The current study attempts to review the phytoconstituents and biological properties of extracts from O. basilicum var. thyrsiflora (Thai basil), with special reference to oral healthcare.

**Taxonomic position**

Ocimum basilicum var. thyrsiflora is commonly recognized as Thai basil. It belongs to the Ocimum genus, which comes from the Greek word “to smell,” and the family Lamiaceae, popularly recognized as the mint family, with the following taxonomic position (Figure 1) (27).

**Classical categorization in Ayurveda**

Thai basil was used by Ayurvedic and Unani physicians to treat ringworm, rashes, and other skin problems in various forms. Ocimum has been used to study the phytoconstituents of essential oil (28). In addition to shrubs, the genus Ocimum contains around 150 species of plants (29,30). It is extensively utilized in the cosmetic, aromatherapy, perfumery, food, and pharmaceutical fields (31,32) and used worldwide due to its unique flavour profile, particularly in Mediterranean cuisine (22). In

![Figure 1. Taxonomic position of Ocimum basilicum var. thyrsiflora plant.](http://www.herbmedpharmacol.com)
Mediterranean countries, *O. basilicum* infusions are popularly used in traditional medication to reduce plasma lipid concentration (33).

*Ocimum* is a genus of over 100 shrubs and herbs originated in tropical and sub-tropical areas and cultivated worldwide (34).

**Botanical description**

*Ocimum basilicum* var. *thyrsiflora* (Thai basil) is a delicate perennial herb, generally planted as an annual plant (Figure 2). Thai basil has shiny green, little serrated, narrow leaves with a sweet, anise-like aroma and gives a hint of licorice, and also a slight spiciness. It grows up to 45 cm (1 ft 6 in) tall and has a square purple stem like the stems of other mint plants. It has opposite and decussate leaves. Its flowers are shaped like a thyrse, as its scientific name suggests. The inflorescence is purple but the flowers are pink when open (Figure 3) (35).

**Biogeography and ecology**

*Ocimum* species grows well in a wide array of climatic conditions and soil types. Cultivation is suitable in alkaline and saline soils with a moderately acidic pH. Plant growth is enhanced by moderate to heavy rainfall, normal humidity, and high temperatures. *O. basilicum* grows in Central and South America, tropical Asia, and Africa, although it is especially popular in China, Japan, Turkey, and Iran (11). Figure 4 shows the distribution of *Ocimum basilicum* var. *thyrsiflora* in India (36).

**Therapeutic and potential applications in ethnomedicines**

In various regions of Asia, *O. basilicum* is known as the goddess Tulsi, and is used in both medicine and orthodox Christian rituals in India (37,38). In the food industry, the traditional use of the plant has been reported as a flavouring agent and perfume (39). It is commonly cultivated in Iran, and it has been used as a medicine (40). In Asian beverages and desserts and traditional medicine, its seeds are used as a source of dietary fibre (41). It is also helped to treat cough, headache, dysentery, and skin problems (42). It is also found in Mediterranean foods, particularly in the south of Europe, for example, it is found in Greek and Italian cuisines (43). *O. basilicum* polysaccharides have long been utilized in traditional Chinese medication to treat cancer (44) and are still widely used in day-to-day life (45).

**Nutritive value of *Ocimum basilicum***

Due to the presence of secondary metabolites for example essential oils, phenols, tannins, anthocyanins, steroids, and flavonoids, *O. basilicum* has long been recognized for its health benefits and has been applied in traditional medicine. The content of magnesium, potassium, and iron is high in *O. basilicum* (Table 1). Potassium and Magnesium, as two of seven essential macro minerals, boost cardiovascular health and nerve impulse transmission while also protecting against several chronic diseases like osteoporosis.
disorders.

It is used as a diuretic and a digestive stimulant. It is rich in a variety of vital elements, including calcium, phosphorus, vitamin A, and vitamin C. It also includes a high concentration of carotenoids like β-carotene, which are transformed into vitamin A inside the body. Carotene is a potent antioxidant that provides much more benefits than vitamin A.

Polyphenols are abundant in basil. Polyphenols are a diverse group of chemicals that include phenolic acids, simple and complex flavonoids, and coloured anthocyanins. They inhibit peroxide oxidation in terms of pharmacological efficacy (46). Per 100 g of fresh material, sweet basil leaves contain water - 87 g, protein - 3 g, fat - 1 mg, carbohydrates - 5 g, fibre - 2 g, and ash - 2 g. Protein and fat content are high, but carbohydrates are low in the seeds.

Sweet basil is a famous savoury herb. Fresh and dried leaves are used in dishes and drinks to provide aroma, warmth, and sweetness, along with pungent and clove notes (47).

Phytochemical studies

*Ocimum basilicum* mainly contains around 20 compounds that have been identified by GC-MS, including estragole, 1,8-cineole, methyl eugenol, linalool, etc. *O. basilicum* also contains monoterpenes, including linalool, thymol, limonene, citral, α-linalool, camphor, β- and estragole. Methyl eugenol is one of the most abundant phytochemicals of *O. basilicum*. Radulović et al reported cichoric acid in fresh basil leaves (48). Phenolics are rich in crude extracts of various morphological parts of *Ocimum*. The presence of anthocyanins is responsible for the flower’s deep purple pigmentation (49). 52.42% of linalool, 18.74% of methyl eugenol, and 5.61% of 1,8-cineole are major compounds identified by high-performance liquid chromatography (HPLC) in *O. basilicum* (48). Minor compounds are myrcene, borneol, and neral, present at 5%, 9%, and 8% w/w, respectively. HPLC was used to identify 14 distinct anthocyanins, 11 of which were cyanidin-based pigments and three of which were peonidin-based pigments (50). Perfumes and cosmetic products are also manufactured using this plant. *O. basilicum* extracts have potencies to inhibit the HIV-1 reverse transcriptase and platelet aggregation (51). Figure 5 shows phytoconstituents of essential oil of fresh *O. basilicum* var. thyrsiflora obtained by hydro distillation (52). Figure 6 shows their chemical structures.

Chemical constituents, extraction methods, and biological activities of *O. basilicum* are given in Table 2.

Pharmacological activities

In various regions of the world, *O. basilicum* has been extensively studied. It exhibits antifungal, antibacterial, antiviral, antioxidant, anti-inflammatory, anticancer, antiulcer, anti-dyspepsia, antiargiardial, wound-healing, and insecticidal properties (Figure 7). It also has antiviral activities, cardiac stimulant, CNS effects, hypoglycemic and hypolipidemic effects, and platelet aggregation inhibition properties.

Antimicrobial activities

Researchers have reported that *O. basilicum* has significant antibacterial activities. Its essential oils have been shown to have antibacterial activity against a number of gram-positive and gram-negative bacteria, mold, and yeast (104). In a study, different chemical extracts (methanol, ethanol, and hexane) of *O. basilicum* were tested for antibacterial effects in vitro. Ethanol extract inhibited the growth of 9 strains of the genera *Bacillus*, *Staphylococcus*, *Escherichia*, and *Acinetobacter* accounting for 6% of the total 146 bacterial strains tested. Hexane and methanol extracts exhibited antibacterial activity against 11% and 13% strains from 6 bacteria families, respectively, *Staphylococcus*, *Micrococcus*, *Escherichia*, *Brucella*,


\[\text{Table 1. Nutritive constituent of fresh basil leaves in 100 g}\]

<table>
<thead>
<tr>
<th>Nutrient value</th>
<th>Nutritive elements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phytonutrients</td>
<td></td>
</tr>
<tr>
<td>3142 mcg</td>
<td>Carotene-β</td>
</tr>
<tr>
<td>46 mcg</td>
<td>Crypto-xanthin-β</td>
</tr>
<tr>
<td>5650 mcg</td>
<td>Lutein-zeaxanthin</td>
</tr>
<tr>
<td>Minerals</td>
<td></td>
</tr>
<tr>
<td>177 mg</td>
<td>Calcium</td>
</tr>
<tr>
<td>385 mg</td>
<td>Copper</td>
</tr>
<tr>
<td>3.17 mg</td>
<td>Iron</td>
</tr>
<tr>
<td>64 mg</td>
<td>Magnesium</td>
</tr>
<tr>
<td>1.15 mg</td>
<td>Manganese</td>
</tr>
<tr>
<td>Vitamins</td>
<td></td>
</tr>
<tr>
<td>5275 IU</td>
<td>Vitamin A</td>
</tr>
<tr>
<td>414.8 mcg</td>
<td>Vitamin K</td>
</tr>
<tr>
<td>18 mg</td>
<td>Vitamin C</td>
</tr>
<tr>
<td>0.80 mg</td>
<td>Vitamin E</td>
</tr>
<tr>
<td>0.209 mg</td>
<td>Pantothenic acid</td>
</tr>
<tr>
<td>68 mcg</td>
<td>Folates</td>
</tr>
<tr>
<td>0.902 mg</td>
<td>Niacin</td>
</tr>
<tr>
<td>0.155 mg</td>
<td>Pyridoxine</td>
</tr>
<tr>
<td>0.076 mg</td>
<td>Riboflavin</td>
</tr>
<tr>
<td>0.034 mg</td>
<td>Thiamin</td>
</tr>
<tr>
<td>Electrolytes</td>
<td></td>
</tr>
<tr>
<td>295 mg</td>
<td>Potassium</td>
</tr>
<tr>
<td>4 mg</td>
<td>Sodium</td>
</tr>
<tr>
<td>23 kcal</td>
<td>Energy</td>
</tr>
<tr>
<td>2.65 g</td>
<td>Carbohydrates</td>
</tr>
<tr>
<td>3.15 g</td>
<td>Protein</td>
</tr>
<tr>
<td>1.60 g</td>
<td>Dietary fiber</td>
</tr>
<tr>
<td>0.64 g</td>
<td>Fat</td>
</tr>
</tbody>
</table>

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**Figure 5.** Phytoconstituents of essential oil of fresh *Ocimum basilicum* var. *thyrsiflora* obtained by hydro-distillation.

**Figure 6.** Chemical structures of phytoconstituents identified in *Ocimum basilicum* var. *thyrsiflora* essential oil (53).

Bacillus, and Acinetobacter accounting for 9% and 10% of the 146 bacterial strains studied. Three *Candida albicans* isolates were also inhibited by the methanol and hexane extracts (105,106).

Budka and Khan (107) discovered that essential oil of *O. basilicum*, *Thymus vulgaris* (thyme), and *Origanum vulgare* (oregano) had bactericidal activity against *Bacillus cereus* in rice-based diets. Only, methanol extracts of *O. basilicum* displayed antibacterial efficacy against *S. aureus*, *Listeria monocytogenes*, *Shigella* sp., *Pseudomonas aeruginosa*, and 2 different strains of *E. coli* reported in a similar study. Peppermint oil and two main ingredients (menthone and menthol), as well as sweet basil oil and its two main constituents (eugenol and linalool) were tested against *Sclerotinia sclerotiorum* (Lib.) and *Rhizopus stolonifer* (Ehrenb. ex Fr.). The essential oil components, specifically linalool, exhibited moderate antifungal activity, whereas eugenol had no effect (108).

In a study, the essential oil from *O. basilicum* was extracted by hydro-distillation process which was then analyzed using GC-MS. Fifteen compounds, representing 74.19% of the total oil, were with considerable antifungal activity against a few pathogenic fungi of plants (109).

**Antiproliferative/anticancer activity**
The essential oils of 17 Thai medicinal plants were examined for antiproliferative activity in murine leukaemia (P388) cell lines and human mouth epidermal carcinoma (KB). In comparison to the P388 cell line, basil oil showed the strongest antiproliferative action in the KB cell line. According to the findings, Thai medicinal plants could be used to treat cancer (110).

**Anti-inflammatory activity**
The anti-inflammatory action of *O. basilicum* L. crude methanolic extracts was established by the inhibition
Table 2. Biological activities, chemical constituents, and extraction methods of *Ocimum basilicum*

<table>
<thead>
<tr>
<th>Chemical compounds</th>
<th>Methods of extraction</th>
<th>Biological activities</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Menthol</td>
<td>Soxhlet solvent extraction</td>
<td>Local anesthetic</td>
<td>(54,55)</td>
</tr>
<tr>
<td>Linalool</td>
<td>Solvent-free microwave extraction, conventional hydro-distillation</td>
<td>Antinociceptive, Antihyperalgesic</td>
<td>(56,57)</td>
</tr>
<tr>
<td>Eugenol</td>
<td>Steam distillation</td>
<td>Anti-cancer, neuro-protective, local anesthetic</td>
<td>(58,59)</td>
</tr>
<tr>
<td>1,8-cineole</td>
<td>Hydro-distillation</td>
<td>Wound healing activity, Antiluerc</td>
<td>(60,61)</td>
</tr>
<tr>
<td>Methyl eugenol</td>
<td>Hydro-distillation</td>
<td>Anesthetic, anticonvulsant</td>
<td>(62,63)</td>
</tr>
<tr>
<td>Limonene</td>
<td>Solvent extraction</td>
<td>Anti-inflammatory, motor relaxant</td>
<td>(64,65)</td>
</tr>
<tr>
<td>β-Elemene</td>
<td>Glyco- and hydro-distillation</td>
<td>Anticancer, antineoplastic</td>
<td>(66,67)</td>
</tr>
<tr>
<td>α-Hergamotene</td>
<td>Cold maceration</td>
<td>Abiotic stress release</td>
<td>(68,69)</td>
</tr>
<tr>
<td>Bornyl acetate</td>
<td>Microwave extraction</td>
<td>Anti-inflammatory, analgesic</td>
<td>(70,71)</td>
</tr>
<tr>
<td>Camphor</td>
<td>Liquid-liquid extraction</td>
<td>Antipruritic, counterirritant</td>
<td>(72,73)</td>
</tr>
<tr>
<td>α-Copaene</td>
<td>Extraction by supercritical fluid</td>
<td>Cytotoxic, antigenotoxic, antioxidant</td>
<td>(74,75)</td>
</tr>
<tr>
<td>β-Caryophyllene</td>
<td>Extraction by supercritical fluid</td>
<td>Antibiotic, antioxidant, anti-carcinogenic</td>
<td>(76,77)</td>
</tr>
<tr>
<td>Chicoric acid</td>
<td>Extraction by solvent microwave</td>
<td>Immunostimulatory, antioxidant</td>
<td>(78,79)</td>
</tr>
<tr>
<td>Farnesene</td>
<td>Distillation by steam</td>
<td>Anti-insecticial, antioxidant</td>
<td>(80,81)</td>
</tr>
<tr>
<td>β-Cadinene</td>
<td>Supercritical fractioned extraction</td>
<td>Antiproliferative, antinociceptive</td>
<td>(82,83)</td>
</tr>
<tr>
<td>Menthyl acetate</td>
<td>Solid-phase microextraction</td>
<td>Antibacterial, antioxidant</td>
<td>(84,85)</td>
</tr>
<tr>
<td>Germacrene</td>
<td>Solvent extraction</td>
<td>Anti-inflammatory, analgesic</td>
<td>(86-88)</td>
</tr>
<tr>
<td>α-Bisabolol</td>
<td>Extraction by supercritical carbon dioxide and in-situ</td>
<td>Anticancer, antibiotic, analgesic</td>
<td>(89-91)</td>
</tr>
<tr>
<td>δ-Gurjunene</td>
<td>Supercritical fluid extraction</td>
<td>Anti-inflammatory, antitumor, anti-oedematous</td>
<td>(92,93)</td>
</tr>
<tr>
<td>δ-Cadinene</td>
<td>Solid-phase microextraction</td>
<td>Antibacterial, antioxidant</td>
<td>(94,95)</td>
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<tr>
<td>Estragole</td>
<td>Hydro-distillation</td>
<td>Neuronal excitability</td>
<td>(96,97)</td>
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<td>Neoisomenthol</td>
<td>Steam distillation</td>
<td>Nasal sensation</td>
<td>(98,99)</td>
</tr>
<tr>
<td>Guaiene</td>
<td>Steam distillation</td>
<td>Antidepressant, antiplatelet, antithrombotic</td>
<td>(100,101)</td>
</tr>
<tr>
<td>Pulegone</td>
<td>Liquid-liquid extraction</td>
<td>Antinociceptive</td>
<td>(102,103)</td>
</tr>
</tbody>
</table>

of main pro-inflammatory mediators and cytokines. A study found that methanol extract of *O. basilicum* aerial parts had a substantial anti-inflammatory effect against macrophages (RAW264.7), human chondrosarcoma (SW1353), and human primary chondrocytes1 (111).

**Antioxidant activity**

Polyphenols of *O. basilicum* have been well known for their antioxidant properties. In one study, polyphenols isolated from methanol extract of *O. basilicum* were tested for antioxidant properties, and found to have the greatest antioxidant activity along with an outstanding synergistic activity on α-tocopherol (112). According to Kim et al, caffeic acid and rosmarinic acid were the strongest antioxidant components of *O. basilicum* (113).

**Antiulcer activity**

In a study, it was found that *O. basilicum* seed extracts had a notable antiulcer effect against ethanol-induced ulceration in animal models. In this experiment, rats were pretreated with 10% Tween 20® (group 1), *O. basilicum* extract (group 2), and cimetidine (group 3). *O. basilicum* extracts and cimetidine exhibited expressively ($P<0.05$) high inhibitory effects and reduction of submucosal oedema, gastric injury, and leucocytes infiltration compared to 10% Tween 20® (114).
Antiviral activity
In a study, apigenin, ursolic acid, and linalool were extracted from crude aqueous and ethanolic extracts of *O. basilicum*; they displayed antiviral effect against coxsackievirus B1 and enterovirus 71, among other viruses. Ursolic acid showed the strongest activity against HSV-1 and EV71, while apigenin had the highest activity against hepatitis-B, hepatitis-B antigen, ADV-3, HSV-2, and surface antigens; linalool had the strongest activity against AVD-II (115).

Hypoglycaemic effects
An aqueous extract of *O. basilicum* had a hypoglycemic effect in normal and streptozotocin-induced diabetic rats (116). *O. basilicum* expressively reduced blood glucose level in normal (*P* < 0.01) and diabetic rats (*P* < 0.001) after a single oral dose treatment. *O. basilicum* caused a significant drop in blood glucose levels (*P* < 0.001) in diabetic rats after 15 days of repeated oral administration, but a less significant reduction (*P* < 0.05) in normal rats. After 15 days of oral treatment, the main pro-inflammatory cytokines were suppressed, along with plasma insulin levels in both normal and diabetic rat; however, the body weight was constant.

Hypolipidemic effects
*Ocimum basilicum* contains polar compounds that may help reduce plasma lipid concentrations, which could help to prevent hyperlipidemia and associated cardiovascular disorders. An aqueous extract of basil had hypocholesterolemic and hypotriglyceridemic effects in hyperlipidemic rats administered by a high-fat diet/ *O. basilicum* reduced total cholesterol level in plasma and liver (*P* < 0.02, *P* < 0.05, respectively), along with triglycerides in plasma and liver (*P* < 0.02, *P* < 0.01, respectively). A similar finding was reported for plasma LDL-cholesterol concentrations (*P* < 0.02). A similar study based on hypolipidemic effects of aqueous extract of *O. basilicum* revealed that the cholesterol (*P* < 0.001) and triglyceride (*P* < 0.05) levels considerably decreased after regular oral administration in diabetic rats (117).

Inhibitory effect on platelet aggregation
In a study, *O. basilicum* reduced platelet aggregation induced by thrombin and ADP in a dose-dependent manner showing its efficacy as an antithrombotic profile *in vivo* (22). Another study revealed that the aqueous extract of *O. basilicum* was investigated against the antiplatelet activity using thrombin and ADP as agonists. ADP-induced platelet aggregation was reduced by 113%, 28.2%, 30.5%, 44.7%, and 53%, while thrombin-induced platelet activation was abated by 15%, 23%, 40%, 38.4%, and 42% (20).

Wound-healing activity
The wound healing properties of the plant were investigated in rats with cutaneous excision wounds. Wounds were treated with honey along with alcohol leaf extract of *O. basilicum* and solcoseryl-jelly healed faster than wounds treated with honey alone (118).

Toxicity effect
On the toxicity of *Ocimum* species, there is limited information. *Ocimum* species toxicities seem to be very low; however, there are some potentially hazardous compounds like quercetin safrole, tryptophan, rutin, and caffeic acid (119).

Oral efficacy of *Ocimum* species
In dental medicine, herbal medicines have achieved high popularity for curing many oral infections and diseases such as lichen planus, leukoplaikia, submucous fibrosis, mouth sores ulcer, dental caries, periodontitis, antibacterial and antifungal infections, etc. Species of *Ocimum* have multifaceted activities due to the presence of compounds like eugenol, linalool, ursolic acid, etc. *O. basilicum* has antibacterial activity against periodontal microbes, for example, Streptococcus mutans, Aggregatibacter actinomycetemcomitans, and Porphyromonas gingivalis. Essential oil from *O. basilicum* can kill oral carcinogenic and biofilm-forming microorganisms, such as Lactobacillus and Streptococcus species (120). *O. basilicum* is also used to relieve dental pain and reduce dental caries. The herbal medicine has antimicrobial properties that reduce periodontitis thereby killing periodontal pathogens. Commercially, these are used to make mouthwash, toothpaste, and a local drug delivery system to treat gingivitis, oral ulcers, and other oral problems (121).

Market available products from *Ocimum* species
Mostly the powder extracts of *O. basilicum* are used as an immunity booster. The different extracts of *O. basilicum* are used as a mouthwash, toothpaste, and gel to prevent microbial infections and inflammation in the gum, thereby maintaining a healthy oral status. Various skin products contain the active ingredients of basil to treat pimples and acne (e.g., facewash, face gel, face serum, oil, etc.). Some examples of market available products of *Ocimum sanctum* (Holy basil) are given in Figure 8.

Ethnomedicinal value of *Ocimum basilicum*
*Ocimum basilicum* was discovered to be an essential medicinal plant used in the traditional healthcare system. Different observations were recorded by studying different plant parts used, modes of administration, different diseases treated, and therapeutic procedures for various diseases. Several diseases have been treated by *O. basilicum*, among which gastrointestinal diseases (22%) accounted for the highest percentage followed by skin infections (17%), respiratory problems (12%), cardiovascular diseases (10%), renal diseases (8%), oral...
infections, eye diseases (7%), muscular or skeletal and gynecological diseases (5%), insect bites (3%), and others (1%) (122).

**Conclusion**

Nowadays healthcare system is receiving more attention through some new innovative approaches in both developed and developing countries. Herbal medications could be a better and more effective alternative in healthcare. This review mainly focused on the distinct pharmacological properties and different chemical compounds present in *O. basilicum*. It has anti-inflammatory, antioxidant, antiulcer, hypoglycemic, hypolipidemic, antimicrobial, anticancer, wound-healing, and other properties. The pharmacological activities are determined by various chemical constituents and the amount present in them. According to various studies, *Ocimum sanctum* (holy basil) leaf extracts, essential oils, and leaf powder could inhibit dental plaques, caries, and periodontitis thereby preserving healthy gum and maintaining a normal healthy oral environment. So, researchers should give more attention to designing some new dental care innovations based on different biological activities and chemical constituents of *O. basilicum*.

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**Authors’ contribution**

SB conceptualized. AS performed the data collection, analysis, validation, and preparation. RB supported the scientific discussions. GN, DK, and AK supported during the validation and preparation of the final manuscript. All authors read, reviewed, and approved the manuscript and edited English language.

**Conflict of interests**

Authors declare that there is no conflict of interest regarding the publication of this article.

**Ethical considerations**

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