

Chemical constituents and medicinal properties of Basil (*Ocimum basilicum*)

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Abstract:- *Ocimum basilicum*, commonly known as basil, is a valuable crop renowned for its essential oils and diverse bioactive compounds, including polyphenols, phenolics, flavonoids, and phenolic acids. Native to tropical regions, this annual herb belongs to the mint family and offers numerous health benefits. Beyond its culinary uses in various dishes, basil has been traditionally employed to address various health issues, including kidney problems, menstrual irregularities, arthritis, and infectious diseases.

The pharmacological properties of basil exhibit:

- 1]Antimicrobial and anti-inflammatory effects ,
- 2]Immunomodulatory and antioxidant activity ,
- 3]Anti-cancer, radioprotective, and anti-diabetic properties ,
- 4]Cardiovascular benefits and anti-arthritis effects ,
- 5]Anti-stress and anti-pyretic activity.

Additionally, basil seed mucilage, or basil seed gum, serves as a versatile hydrocolloid with applications :-

- Thickening agent
- Stabilizer
- Fat substitute.
- Texture modifier

Overall, basil's multifaceted benefits underscore its significance in both culinary and pharmaceutical contexts.

Introduction:- The *Ocimum* genus comprises over 30 diverse species of herbs and shrubs, characterized by varying morphology, flower colors, growth habits, chemical composition, leaves, and stems. Originating from Asia, Central and South America, and Africa, this genus has been revered for centuries. In ancient Greece, *Ocimum basilicum* was esteemed as the "herb of kings." Today, it's known by various names across cultures. Notable

English: Basil	French: Basilic.	German: Basilikum
Spanish: Albahaca	Prsian: Reihan.	Arabic: Rehan

members of the *Ocimum* genus include Other species have distinct common names: ^{1,2,3,4}

- *O. Campechianum* (Least Basil, Peruvian Basil) - *O. Gratissimum* (African Basil, Tree Basil)
- *O. Xcitiroidorum* (Lemon Basil). - *O. Kilimandscharicum* (Camphor Basil)

Basil's aromatic profile is dominated by volatile components:

- Linalool - Methyl chavicol. - Eugenol. - Bergamotene. - Methyl cinnamate

This versatile herb plays a significant role in various cuisines:^{5,6,7}

- 1}Iranian
- 2} Italian
- 3}Chinese
- 4}Indian

Basil occurrence, cultivation, classification and variation in species :-

Ocimum basilicum L., commonly known as basil, is a valuable crop prized for its essential oil, medicinal properties, and culinary uses. Belonging to the Lamiaceae family, basil thrives in tropical and subtropical climates.⁸

Classification:-

Kingdom: Plantae.: - Phylum: Magnoliophyta - Class: Magnoliopsida - Order: Lamiales. - Family: Lamiaceae - Genus: *Ocimum*^{9,10}

Characteristics:- High germination rate (95-98% in laboratory, 10-15% in field conditions) Consists of main stem, nodes, internodes, dominant growing tip, future stem growth, and leaves. All parts usable (leaves, flowers, essential oil, ornamental)^{11,12}

Varieties:- Sweet basil. - Purple basil. - Lemon basil. - Cinnamon basil. - Anise basil. - Fine leaf basil. - Bush basil^{13,14}

Pests and Diseases: - Pests: Aphids, leafhoppers, whitefly

-Diseases: Fusarium wilt, leaf spot, gray mold, damping off.¹⁵

Environmental Sensitivity:-

- Sensitive to drought stress, impacting yield, essential oil content, and chemical constituents

- Requires efficient water use in semi-arid regions

Harvest:- Dry stem yield: 1.2-2 t/ha (fresh weight: 8-10 t/ha)

Key Diseases:- Fusarium wilt (*Fusarium oxysporum* f. Sp. *Basilicum*)

-Leaf spot (*Pseudomonas cichorii*)

-Gray mold (*Botrytis cinerea*)

-Damping off/root rot (*Rhizoctonia solani*; *Pythium* spp.)

-Downy mildew (*Peronosporabelbahrii*)^{16,17}

Basil nutritional composition and chemical constituents :-

Nutritional Composition

1. Energy: 22 kcal 2. Carbohydrates: 4.8g. 3. Fiber: 2.5g. 4. Protein: 3.2g. 5. Fat: 0.6 6. Water: 92.1g

7. Minerals –

-Potassium (145mg) - Manganese (45mg). - Copper (35mg)

- Iron (25mg). - Calcium (20mg)

8. Vitamins - Vitamin K (25mcg). - Vitamin C (15mg). - Folate (10mcg). - Vitamin A (10mcg)

Chemical Constituents

1. Essential Oils: - Linalool (50-70%). - Methyl chavicol (10-20%). - Eugenol (5-15%). - Bergamotene (5-10%). - Methyl cinnamate (2-5%)

2. Flavonoids:- Quercetin. - Kaempfero. - Luteoli. - Apigenin

3. Phenolic Acids:- Rosmarinic acid - Caffeic acid - Ferulic acid

4. Terpenoids:- Ursolic acid. - Oleanolic acid - Beta-sitosterol

5. Alkaloids:- Basilicin. – Basilamin

Bioactive Compounds

1. Antioxidants. 2. Anti-inflammatory compounds. 3. Antimicrobial agent. 4. Anticancer properties. 5. Cardiovascular protective agent

Variations in Chemical Constituents

1. Climate and geography. 2. Soil type and fertility. 3. Cultivar and genetic variation. 4. Harvesting and processing methods^{18, 19, 20}

Medicinal uses and potential HEALTH benefits in traditional medicine:-

Basil holds significant cultural, medicinal, and culinary importance across various regions:

In Asia:- Revered as the goddess Tulsi in some parts.

Traditional medicine in India for centuries. - Used in orthodox Christian rituals

Culinary and Medicinal Applications:- Flavoring agent in food industry.

Ingredient in dental and oral products, fragrances

Used as vegetable and medicinal tincture in Iran.

Source of dietary fiber in Asian beverages and desserts

Traditional Medicine:- Treats cough, headache, worms, diarrhea, skin infections.

Part of Mediterranean diets (Italian, Greek cuisines)

Traditional Chinese Medicine:- Basil polysaccharides used for cancer treatment^{21, 22},

1]Antimicrobial and anti-inflammatory effects :-

Antimicrobial Effects:

Inhibits growth of bacteria (E. Coli, Staphylococcus aureus, Bacillus subtilis)

Exhibits antifungal activity against Candida albicans, Aspergillus niger

Shows antiviral properties against HSV-1, HSV-2

Effective against foodborne pathogens (Salmonella, Listeria)

Anti-Inflammatory Effects:

Reduces inflammation in arthritis, edema, and pain

Inhibits pro-inflammatory cytokines (TNF- α , IL-1 β , IL-6)

Suppresses COX-2 expression, reducing inflammation

Exhibits antioxidant activity, scavenging free radical

2]Immunomodulatory and antioxidant activity

Immunomodulatory Effects:

Enhances immune response: Stimulates macrophage activation, increasing phagocytosis.

Cytokine modulation: Regulates IL-2, IL-6, TNF- α , and IFN- γ production.

Immunoglobulin production: Increases IgG, IgM, and IgA levels.

Antigen presentation: Enhances dendritic cell function.

Anti-inflammatory cytokines: Increases IL-10, IL-22, and TGF- β production.

Antioxidant Activity:

Free radical scavenging: Neutralizes ROS, RNS, and DPPH.

Antioxidant enzymes: Enhances SOD, CAT, GPx, and GR activity.

Lipid peroxidation inhibition: Reduces oxidative stress.

DNA damage protection: Prevents oxidative damage.

Cell membrane protection: Maintains membrane integrity.

3]Anti-cancer, radioprotective, and anti-diabetic properties

Anti-Cancer Properties:

Inhibits cancer cell growth and proliferation

Induces apoptosis (cell death) in cancer cells

Anti-angiogenic effects, reducing tumor growth

Enhances chemotherapy efficacy

Inhibits cancer cell migration and invasion

Radioprotective Properties:

Protects against ionizing radiation damage

Reduces oxidative stress and DNA damage

Enhances antioxidant defenses

Prevents radiation-induced apoptosis

Mitigates radiation-induced inflammation

Anti-Diabetic Properties:

Reduces blood glucose levels

Enhances insulin sensitivity

Inhibits glucose absorption

Protects against oxidative stress

Regulates lipid metabolism

4]Cardiovascular benefits and anti-arthritis effects

Cardiovascular Benefits:

Lipid profile improvement: Reduces triglycerides, LDL cholesterol

Antihypertensive effects: Lowers blood pressure

Endothelial protection: Enhances nitric oxide production

Anti-inflammatory effects: Reduces cardiovascular inflammation

Antioxidant activity: Protects against oxidative stress

Platelet aggregation inhibition: Prevents blood clots

Improves cardiovascular function: Enhances cardiac output, reduces cardiac risk

Anti-Arthritic Effects:

Anti-inflammatory effects: Reduces joint inflammation

Analgesic effects: Relieves pain

Antioxidant activity: Protects against oxidative stress

Immunomodulation: Regulates immune response

Joint protection: Inhibits cartilage degradation

Reduces cytokine production: Decreases inflammatory mediators

5]Anti-stress and anti-pyretic activity

Anti-Stress Activity:

Adaptogenic effects: Enhances stress tolerance

Anxiolytic effects: Reduces anxiety

Antidepressant effects: Improves mood

Neuroprotection: Protects against neurodegeneration

Corticosterone regulation: Normalizes stress hormone levels

Anti-Pyretic Activity:

Fever reduction: Decreases body temperature

Anti-inflammatory effects: Reduces inflammation

Analgesic effects: Relieves pain

Antioxidant activity: Protects against oxidative stress.^{23, 24, 25, 26}

-Thickening agent :

Food industry: Basil seeds are used as a natural thickener in:

Beverages (juices, smoothies)

Desserts (puddings, custards)

Sauces (dressings, marinades)

Baked goods (cakes, cookies)

Pharmaceutical industry: Basil seeds are used as a thickening agent in:

Suspensions

Emulsions

Gels

Cosmetics Basil seeds are used in:-

Skincare products (moisturizers, creams)

Haircare products (conditioners, masks)

Stabilizer.

Food industry:- Basil seeds stabilizer

Dressings and sauces

Beverages (juices, smoothies)

Desserts (puddings, custards)

Ice cream

Pharmaceutical industry:- Basil seeds stabilizer

Emulsions

Suspension

Gels

Cosmetics: Basil seeds stabilize:- Skincare products (moisturizers, creams)

Haircare products (conditioners, masks)

Fat substitute.

Baked goods (cakes, cookies, muffins)

Dairy products (yogurt, cheese, ice cream)

Meat products (sausages, burgers)

Sauces and dressings

Frozen desserts

Texture modifier

Food industry :- Baked goods (cakes, cookies, muffins)

Dairy products (yogurt, cheese, ice cream)

Meat products (sausages, burgers)

Sauces and dressings

Frozen desserts

Cosmetics :- Skincare products (moisturizers, creams)

Haircare products (conditioners, masks)

Pharmaceuticals:- Tablets

Capsules

Suspensions

Emulsifier^{27, 28, 29, 30}

Conclusion:- *Ocimum americanum* L., *Ocimum basilicum* L., *Ocimum hispidulum* Schum, *Ocimum tenuiflorum* L., *Ocimum sanctum* L., and *Ocimum ratissimum* L. Are the most significant members of the *Ocimum* genus. The main volatile oils found in basil include bergamotene, eugenol, methyl chavicol, and linalool. Methyl cinnamom as well. Additionally, Indian, Chinese, Italian, and Persian cuisines are linked to basil. The main stem, nodes, internodes, dominant growing point, future stem development, and leaves make up a basil plant's anatomy. The two primary phenolic compounds in basil are phenolic acids and flavonol-glycosides. Stearic acid, Oleic acid, Palmitic acid, Linoleic acid, Myristic acid, α -Linolenic acid, Capric acid, Lauric acid, and Arachidonic acid make up the majority of the fatty acid makeup of basil species. Increased temperatures and light levels affect an antioxidant's ability. The most significant antioxidants found in basil include p-hydroxybenzoic, quercetin, rutin, apigenin, vanillic, and rosmarinic acids. α - and β -Pinene, methyl chavicol, 1,8 cineole, linalool, occimene, Borneol, Geraneol, B-Caryophyllone, n-Cinnamate, and eugenol are the essential oils found in basil. Eugenol, chavicol, and terpenoids are the three most significant essential oils found in basil. It is extensively grown and used as a vegetable and medicinal tincture in traditional herbal treatments.

Basil's most significant pharmacological applications include its ability to fight cancer, protect against radiation, fight microbes, reduce inflammation, modulate immunity, reduce stress, fight diabetes, fight rheumatism, fight anti-oxidants, and more. As a preventative measure and in heart disease. Known by most as basil seed gum, basil seed mucilage. Galactose, rhamnose, mannose, arabinose, glucose, galacturonic acid, and glucuronic acid make up the BSG. Because of the SUPER-BSG fraction and its great chain flexibility, BSG exhibits a random coil conformation. BSG is a surface-active, emulsifying, thickening, stabilising, fat-substituting, texturizer, and hydrocolloid that can enhance the quality of frozen meals. It Regarded as commercial hydrocolloids

in the food sector due to their unique behaviour and ease of extraction. Based on the results, it is recommended that basil be used in the food and pharmaceutical industries.

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