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Research Progress on Chemical Composition and Clinical Effect of *Ocimum basilicum*

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Abstract *Ocimum basilicum* is a common herb well known for its importance for ornamental and therapeutic purposes. Chemical components that have been isolated from *O. basilicum* plants include terpenoids, alkaloids, flavonoids, tannic acid, saponin glycosides, and ascorbic acid. *O. basilicum* has liver protection, immune regulation, anti-hyperglycemia, hypolipidemic, anti-toxin, anti-inflammatory, anti-bacterial and anti-fungal effects. This paper aims to review the latest progress in phytochemical research and pharmacological research of *O. basilicum*, which will assist various practitioners and clinicians in understanding the traditional and modern uses of *O. basilicum*.

Key words *Ocimum basilicum*, Phytochemical research, Pharmacological research

1 Introduction

Chinese herbal medicine, also called botanical medicine, refers to using seeds, fruits, roots, leaves, bark or flowers of plants for medicinal purposes. China has a long history of use of herbal medicines. With the improvement in the analysis and quality control and the progress in clinical research, the value of Chinese herbal medicine in the treatment and prevention of diseases is becoming higher and higher[1].

2 Classification

Ocimum belongs to the family Lamiaceae. There are about 35 kinds of aromatic annual and perennial herbs and shrubs, which are mainly native to the tropical and warm temperate regions of the world, including some important medicinal species[2].

2.1 *Ocimum americanum* *O. americanum* is produced in tropical Africa. It is called hairy or ancient basil, and is annual herbaceous plant. Ued in medicine, *O. americanum* show antibacterial and antioxidant activity[3]. *O. americanum* contains volatile oils, flavonoids, carbohydrates, phytosterols, tannins and fixed oils.

2.2 *O. basilicum* *O. basilicum* is herbaceous plant that can be used for cooking. Many cooking and ornamental basil varieties and species have hybrids. *O. basilicum* has a strong flavor similar to *Illicium verum*, is a common ingredient in Thai food, and is often used for season curry and frying potato chips. *O. basilicum* has been widely applied as a folk remedy for a large number of diseases, including cancer, convulsions, deafness, diarrhea, epilepsy, gout, snoring, impotence, confusion, nausea, sore throat, toothache and whooping cough, and is also usually used as a mosquito repellent[4].

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2.3 *Ocimum gratissimum* *O. gratissimum*, also known as African basil, or Hawaiian wild basil, has antibacterial, anti-diabetic, anti-tumor, anti-cancer, diarrhea, anti-fertility, hepatoprotective and therapeutic effects of gastrointestinal diseases[5].

2.4 *Ocimum micranthum* *O. micranthum*, also known as Amazon basil, is a South American variety commonly used for the odor of Ayahuasca (entheogenic brew made out of Banisteriopsis caapi vine, often in combination with various other plants. It can be mixed with the leaves of Chacruna or Chagropanga, dimethyltryptamine (DMT)-containing plant species). It is reported that it helps to avoid poor vision. *O. micranthum* has antibacterial, antiprotozoal and antioxidant activity[6].

2.5 *Ocimum tenuiflorum* *O. tenuiflorum*, as an aromatic plant of the Labiatae family, is widely distributed throughout the tropical areas and is widely used as a weed for cultivated plants. *O. tenuiflorum* is an erect, multi-branched sub-shrub, 30 - 60 cm tall, has hairy stems and simple opposite green leaves, and has strong aroma. Leaves have petiole, are ovate, up to 5 cm long, and usually slightly toothed. Flowers are purplish in the slender racemes of dense spirals. There are two main morphological types: green leaf (Sri or Lakshmi tulsi) and purple leaf (Krishna tulsi). It has antioxidant activity and is also used for memory improvement.

2.6 *Ocimum sanctum* In Hindi, *O. sanctum* is called tulsi, in English, it is called St. Basil. It is an upright, soft and furry aromatic herb, it can be found in various parts of India. *O. sanctum* is often planted in garden. In the culture process, there are two types of St. Basil, namely, Krishna tulsi and Sri tulsi & tulsi. St. Basil is considered a sacred plant by Hindus and used as a medicinal plant for various diseases in the daily work of Indian families. It has some medical functions such as anti-cancer, antifertility, anti-diabetic and treatment of other diseases[7].

2.7 *Ocimum kilimandscharicum* Economically, *O. kilimandscharicum* is an important medicinal perennial herb widely distributed in East Africa, India and Thailand, and widely planted in the tropical areas.

3 Botanical characteristics

O. basilicum is an erect branching herb, 0.6 – 0.9 m tall, glabrous, more or less pubescent. Stems and branches are green or sometimes purplish. *O. basilicum* leaves are simple, 2.5 – 5.0 cm or longer, ovate, entire or more or less dentate or lobes cuneate and entire base. The petiole is 1.3 – 2.5 cm long. The leaves have many volatile oils that secrete strong flavors like oil glands. There are spirally dense racemes, where the end is usually much longer than lateral. Bracts are culm, shorter than calyx, ovate and acute. Calyx is 5 mm long, expanded in fruit period, and has very short pedicels. The lower lip of its two central teeth is longer than the round upper lip. The 8 – 13 mm long corolla is white, pink or purplish, glabrous or more or less pubescent. The upper filaments slightly applied with stamens are arranged in a toothed manner at the base. Small nuts are approximately 2 mm long, elliptic, black and dentate. Flowers have five sepals, and remain fused into a two-lip calyx[8].

Basil can be propagated through seeds and transplanting. Its flowers have pedicels, up to 18 inches long. Basil thyme seeds are black, very small, oval, about 1 mm in the middle and 2 mm in length. Seedlings are kept in the nursery and transplanted to the farm. Once shrubs are set up, they can be harvested three times a year for more than three years. It needs well-drained soil, but it performs well in clay and sandy soil, with an average annual rainfall of 1 250 mm, a fairly high temperature and a height of up to 900 mm.

4 Chemical properties

4.1 Chemical composition Seed oil of *O. basilicum* contains α-pinene (1.23%), terpene (7.32%), β-myrcene (1.58%), ethylamyl-methanol (0.88%), 1-purelyne (0.26%), α-terpinene (0.33%) (0.62%), dl-limonene (13.56%), 1,8-octene (0.85%), β-omega (2.00%), γ-terpinene (0.88%), trans-arsenene (0.49%), α-terpinene (1.33%), linalool (1.70%), cis salicylic acid (0.47%), camphor (56.07%), terpineol (3.50%), myrtenol (1.24%), trans caryophyllene (0.33%), germarcrene-d (0.43%). Ground parts of *O. basilicum* contains α-pinene (1.23%), terpene (7.32%), β-myrcene (1.58%), 1-purelyne (0.26%), α-terpinene (0.33%), p- (0.62%), dl-limonene (13.56%), 1,8-octene (0.85%), β-omega (2.00%), γ-terpinene (0.88%), trans-arsenene (0.47%), terpinene (1.33%), trans-purelyne (0.49%), linalool (1.70%), camphor (56.07%), terpinen-4-ol (3.50%), myrtenol (1.24%), trans caryophyllene (0.33%), and germacrene D (0.43%)[9]. Aqueous extract of *O. basilicum* leaves contains camphor, 1,8-cineole, limonene, trans-caryophyllene, terpene, myrtenol, α-terpineol, endo-borneol, and linalool[10]. *O. basilicum* leaves also contain flavonoids, tannins, saponins, sterols, carbohydrates, proteins and triterpenoids. These chemical components mainly adjust various biological activities.

The chemical composition depends on its life stage and cultivation site. *O. basilicum* contains different amounts of essential oils. Hussain *et al.*[11] studied the composition of *O. basilicum* influenced by summer, autumn, winter and spring. They found that the content of essential oils is different in different seasons. The content of essential oils in *O. basilicum* was the highest in winter (0.8%) and significantly declined to 0.5% in summer ($P < 0.05$). The content of oxygenated monoterpenoids was higher in the samples collected in winter (68.9%), and the content in summer was higher in sesquiterpene olefins (24.3%). There was a significant difference in the content of most chemical components in different seasons ($P < 0.05$).

4.2 Drying method In a study carried out by Polatc[12], *O. basilicum* was dehydrated using five different drying methods (contact drying, oven drying, shade open atmosphere drying, sun drying and microwave drying). For all drying methods, drying properties (drying time, final moisture content), drying kinetics, color analysis, and essential oil analysis were performed. The results of the study indicate the air heated to 45 – 55℃ is suitable for drying *O. basilicum*.

4.3 Extraction method Soran[13] used three different extraction methods (impregnation, ultrasonic and microwave field extraction) to extract essential oils from *O. basilicum*. The extract was analyzed by thin-layer chromatography / high performance thin-layer chromatography (TLC/HPTLC) technology, to obtain fingerprint information. A gas chromatograph with flame ionization detection was used to characterize the extraction efficiency and to identify terpenoid bioactive compounds. It can be concluded that the most effective extraction techniques are microwave and ultrasonic impregnation. The best extraction solvent system is ether + ethanol (1∶1, *v/v*).

4.4 Aroma characteristics Klimankova *et al.*[14] analyzed the aroma characteristics of five *O. basilicum* samples. A headspace solid-phase microextraction method coupled with gas chromatography-ion trap mass spectrometry (GC-IMS) has been developed and applied to organic and conventional conditions from two kinds of volatile compounds grown on two kinds of *O. basilicum*. Full-scale two-dimensional gas chromatography coupled to time-of-flight mass spectrometry (TOFMS) was used to confirm the identity of the volatile components of *O. basilicum* headspace extracted by solid-phase microextraction. Linalool, methylcamphorol, eugenol, bergamot and methyl cinnamate are the main volatile components, and it has been provided that their relative contents can distinguish the cultivars examined. Compared to fresh *O. basilicum* leaves, some sesquiterpenes in dried and frozen leaves have relatively low relative amount of hydrocarbon benzene compounds and monoterpenoid hydrocarbons. Sensory analysis of all tested samples demonstrated differences between the evaluated varieties.

5 Traditional functions

In traditional medicine, *O. basilicum* is widely used to treat colds, coughs, abdominal pain, measles, and diarrhea. *O. basilicum* leaves treat chest tightness, coughs and colds through sniffing the broken leaves or breathing boiling vapors of leaves. Indoctrina-

tion of leaves is a method for treating measles. Essential oils have a biologically active ingredient that can act as an insect repellent, especially for mosquitoes and storage pests. Some local farmers mix the stored food with dried *O. basilicum* leaves to prevent damage of stored foods from pests[15]. It shows antibacterial and antioxidant activity. Besides, it is also used for viral infections, odor, anorexia and wound healing. Put into pot or cooked to boiling, *O. basilicum* can generate aroma. In the Mediterranean area, *O. basilicum* is used for decoration.

6 Pharmacological effects

6.1 Anti-oxidant activity In the action of UV-B, the regulation of enzyme and non-enzymatic antioxidants was observed in *O. kilimandscharicum*. The changes of lipid peroxidation and free radical content in leaves were studied. Lipid peroxidation as measured by MDA levels increased with the increase in the dose of UV-B and was higher at higher doses of radiation. Restored leaves showed lower MDA content and hydroxyl radicals. The content of ascorbic acid, flavonoids and proline in leaves restored from UV-B was highly increased. The results indicate that a higher ability to scavenge free radicals and a more effective antioxidative capacity use thiobarbituric acid assays in the liver and muscle assay system of the ovarian model. This shows that *O. basilicum* has great potential as an antioxidant due to the rich flavonoids[16]. The protective effects of essential oils and water soluble extracts from three different varieties of sweet *O. basilicum* have been evaluated in cultured cardiomyocytes. According to experimental results, (i) antioxidant activity *in vitro* can not predict biological activity; (ii) *O. basilicum* can produce extracts with significantly different protective effects compared with compositions and extraction techniques. In addition, variations among different cultivars have also been discovered.

6.2 Antibacterial activity Essential oils of the ground parts of *O. basilicum* show antimicrobial activity against Gram-positive bacteria (*Staphylococcus aureus*, *Enterococcus faecalis*), Gram-negative bacteria (*Escherichia coli*, *Pseudomonas aeruginosa*) and *Candida albicans*[17]. *O. basilicum* roots have significant antibacterial activity against a variety of bacteria, such as *Bacillus oligosaccharides*, *Bacillus stearothermophilus*, *Bacillus thuringiensis*, *Bacillus subtilis*, *Lactobacillus casei*, *Lactobacillus plantarum*, *Micrococcus luteus*, *S. aureus*, *etc.*

6.3 Analgesic activity The analgesic activity of methanol extract of *O. basilicum* was evaluated by tail immersion in Swiss mice. The extract showed the analgesic activity equivalent to standard drug aspirin at a concentration of 200 mg/kg[18].

6.4 Cardiovascular diseases The antihypertensive and antithrombotic effects of *O. basilicum* on prostaglandins were examined. *O. basilicum* and its extracts increased 6-keto-PGF1α in a dose-dependent and time-dependent manner and reduced the production of PGE2 and TXB2. This may indicate simultaneous inhibition of COX-2 and stimulation of endothelium COX-1. In this regard, the butanol seems to be more promising[19].

6.5 Anti-hepatotoxicity The protective effect of the methanol extract of *O. basilicum* on hematological toxicity of benzene-induced Swiss albino mice was evaluated. The results showed that the secondary metabolites of the methanol extract of *O. basilicum* leaves, which is mainly composed of *O. basilicu* volatile oil and monoterpenoid geraniol and its oxidized citral, could regulate the cell cycle disorder and hematological abnormalities induced by benzene in mice.

From the methylene chloride extract of the hairy root culture of *O. basilicum* (Lamiaceae), six species identified as Betula Linn., oleanolic acid, ursolic acid, 3-epischadic acid, alphitolic and euscaphic acid were isolated. All tested compounds showed hepatoprotective activity comparable to oleanolic acid and ursolic acid[20].

6.6 Hypoglycemic effect The hypoglycemic activity *in vitro* of *O. basilicum* extract was studied. It arrived at the conclusion that *O. basilicum* extracts that inhibit the activity of antioxidants and possibly α-glucosidases and α-amylases provide positive benefits for the control of diabetes[21].

6.7 Antihypertensive effect The possible antihypertensive effects of *O. basilicum* extracts in renovascular hypertensive rats were examined. The effect of *O. basilicum* on blood pressure, cardiac hypertrophy, and ET is consistent with the role of ET invertase, and this is worthy of further investigation[22].

6.8 Vasodilation and antiplatelet effect The endothelium-dependent vasodilation and antiplatelet aggregation activities of *O. basilicum* extracts were studied. The results showed that compared with NCG, HCD statistics reduced vasorelaxation in HCG ($P < 0.001$) and increased vascular response to phenylephrine ($P < 0.02$). *O. basilicum* as a medicinal plant may be beneficial to the cardiovascular system[23].

6.9 Anti-inflammatory effects We evaluated the effect of *O. basilicum* fruit oil on acute inflammatory reaction in male Wistar rats induced by rosin oil. *O. basilicum* fruit can significantly reduce the total white blood cell count, the percentage of monocytes, activate phagocytic cells, and have a certain inhibitory effect on NO synthesis. Compared with diclofenac, *O. basilicum* tincture has less inhibition of all parameters. *O. basilicum* has an important anti-inflammatory effect on the acute bone marrow reaction and has a certain inhibitory effect on NO synthesis[24].

6.10 Antithrombotic effects The effects of aqueous extracts of *O. basilicum* on platelet aggregation and experimental thrombosis were studied. *O. basilicum* has an inhibitory effect on ADP and thrombin-induced platelet aggregation in a dose-dependent manner and has an in vivo antithrombotic effect, which gradually develops within 7 d, and disappears within 3 – 7 d. It is now necessary to further characterize the active components[25].

7 Discussions

In recent years, traditional medicine has become a potential source of drugs fore treatment of chronic, degenerative, environmental, lifestyle and stress-related diseases. The idea of using medicinal

plants to treat human diseases is not new, and the use of traditional medicinal plants is still very popular in many developing countries. *O. basilicum* is a very important medicine that has traditionally been used to treat many diseases. The wide scope and diversity of *O. basilicum* may be the result of the synergistic effect of its phytochemical composition. In this paper, we reviewed literature of *O. basilicum*, to provide evidence-based scientific verification for some of the behavioral and therapeutic uses of *O. basilicum*. However, there is no detailed description of compounds related to these activities. It is necessary to make further study, to satisfy the demands of research and development.

References

[1] HOZAYEN WG, EL-DESOUKY MA, SOLIMAN HA, *et al.* Antiosteoporotic effect of *Petroselinum crispum*, *Ocimum basilicum* and *Cichorium intybus* L. in glucocorticoid-induced osteoporosis in rats[J]. BMC Complementary and Alternative Medicine, 2016, 16(1):1 - 11.

[2] CARDOSO NNR, ALVIANO CS, BLANK AF, *et al.* Synergism effect of the essential oil from *Ocimum basilicum* var. *Maria bonita* and its major components with fluconazole and its influence on ergosterol biosynthesis [J]. Evidence-based Complementary and Alternative Medicine: eCAM, 2016, 2016(7 - 8): 5647182.

[3] LIU BB, CHEN W, CHU X, *et al.* *Mariniluteicoccus endophyticus* sp. nov. an endophytic actinobacterium isolated from root of *Ocimum basilicum*[J]. International Journal of Systematic and Evolutionary Microbiology, 2016, 66(3): 1306 - 1310.

[4] PEDRO AC, MOREIRA F, GRANATO D, *et al.* Extraction of bioactive compounds and free radical scavenging activity of purple basil (*Ocimum basilicum* L.) leaf extracts as affected by temperature and time[J]. Anais Da Academia Brasileira De Ciencias, 2016, 88(2):1055.

[5] SHAROPOV FS, SATYAL P, ALI NAA, *et al.* The essential oil compositions of *Ocimum basilicum* from three different regions: Nepal, Tajikistan, and Yemen[J]. Chemistry & Biodiversity, 2016, 13(2): 241 - 248.

[6] LIAROS S, BOTSIS K, XYDIS G. Technoeconomic evaluation of urban plant factories: The case of basil (*Ocimum basilicum*)[J]. Science of The Total Environment, 2016,45(554 - 555): 218 - 227.

[7] ELSOUD NHA, DEABES M, ELKASSEM LA, *et al.* Chemical composition and antifungal activity of *Ocimum basilicum* L. essential oil[J]. Open Access Macedonian Journal of Medical Sciences, 2015, 3(3): 374 - 379.

[8] JAYAWEERA DMA. Medicinal plants, (indigenous and exotic) used in ceylon[M]. Colombo: The National Science Foundation of Sri Lanka, 1981.

[9] CHENNI M, El ABED D, RAKOTOMANOMANA N, *et al.* Comparative study of essential oils extracted from egyptian basil leaves (*Ocimum basilicum* L.) using hydro-distillation and solvent-free microwave extraction [J]. Molecules, 2016, 21(1): E113.

[10] SRIVASTAVA S, CONLAN XA, ADHOLEYA A, *et al.* Elite hairy roots of *Ocimum basilicum*, as a new source of rosmarinic acid and antioxidants[J]. Plant Cell Tissue & Organ Culture, 2016, 126(1):19 - 32.

[11] HUSSAIN AI, ANWAR AF, SHERAZI STH, *et al.* Chemical composition, antioxidant and antimicrobial activities of basil (*Ocimum basilicum*) essential oils depends on seasonal variations[J]. Food Chemistry, 2008 , 108(3): 986 - 995.

[12] POLATC H, TARHAN S. The effects of various drying methods on the drying time and quality of Basil (*Ocimum basilicum*) [J]. Ziraat Fakültesi Dergisi, 2009, 26(1): 61 - 70.

[13] SORAN ML, COBZAC SC, VARODI C, *et al.* The extraction and chromatographic determination of the essentials oils from *Ocimum basilicum* L. by different techniques[J]. Journal of Physics, 2009, 182(5): 1 - 5.

[14] KLIMANKOVA E, HOLADOVA K, HAJSLOVA J, *et al.* Aroma profiles of five basil (*Ocimum basilicum* L.) cultivars grown under conventional and organic conditions[J]. Food Chemistry, 2008, 107(3): 464 - 472.

[15] RASHIDIAN A, ROOHI P, MEHRZADI S, *et al.* Protective effect of *Ocimum basilicum* essential oil against acetic acid-induced colitis in rats [J]. Journal of Evidence-based Complementary & Alternative Medicine, 2016, 21(4): NP36.

[16] BHUVANESHWARI K, GOKULANATHAN A, JAYANTHI M, *et al.* Can *Ocimum basilicum* L. and *Ocimum tenuiflorum* L. in vitro culture be a potential source of secondary metabolites[J]. Food Chemistry, 2016,41(194):55 - 60.

[17] SILVA VA, SOUSA JPD, PESSOA HDLF, *et al.* *Ocimum basilicum*: Antibacterial activity and association study with antibiotics against bacteria of clinical importance[J]. Pharmaceutical Biology, 2016, 12(5): 863 - 867.

[18] CHOUDHURY GB, PRABHAT KJ, NAYAK BS, *et al.* Tripathy SK. Phytochemical investigation and evaluation of analgesic activity of leafy extracts of various ocimum (tulsi) species[J]. The Indian Pharmacist, 2010, 8(12): 67 - 70.

[19] AIHETASHAM A, AKHTAR MS, UMER M, *et al.* Bioactivity of extracts of *Foeniculum vulgare* and *Ocimum basilicum* against *Heterotermes indicola* (Wasmann)[J]. Pakistan Journal of Zoology, 2017, 49(10): 7.

[20] EZEANI C, EZENYI I, OKOYE T, *et al.* *Ocimum basilicum* extract exhibits antidiabetic effects via inhibition of hepatic glucose mobilization and carbohydrate metabolizing enzymes:[J]. Journal of Intercultural Ethnopharmacology, 2017, 6(1):22 - 28.

[21] EZEANI C, EZENYI I, OKOYE T, *et al.* *Ocimum basilicum* extract exhibits antidiabetic effects via inhibition of hepatic glucose mobilization and carbohydrate metabolizing enzymes[J]. Journal of Intercultural Ethnopharmacology, 2017, 6(1): 22 - 28.

[22] GHAREBAGHI A, HAGHIGHI MA, AROUIEE H. Effect of cadmium on seed germination and earlier basil (*Ocimum basilicum* L. and *Ocimum basilicum* var. *purpurescens*) seedling growth[J]. Trakia Journal of Sciences, 2017, 15(1):1 - 4.

[23] GOUDOUM A. Antioxidant potential of *Ocimum basilicum* (Lamiaceae) essential oil as preservation of the physicochemical properties of palm oil during one month[J]. International Journal of Nutrition and Food Sciences, 2017, 6(4):181.

[24] SHETTY P. Chemical coupling of glucoamylase produced by Arthrobotrys conoides onto cotton cloth and *Ocimum basilicum* seeds and characterization of the immobilized enzyme[J]. Journal of Microbiology Biotechnology & Food Sciences, 2017, 6(2):758 - 763.

[25] SNEZANA F, BRANIMIR P, SENKA V, *et al.* Optimization of microwave-assisted extraction of polyphenolic compounds from *Ocimum basilicum*, by response surface methodology[J]. Food Analytical Methods, 2017, 10(7): 1 - 11.