Progress in Chemical Constituents and Pharmacological Effects of Citrus medica L. var. sarcodactylis Swingle

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Abstract Citrus medica L. var. sarcodactylis Swingle is known as Foshou fruit that can be used as Chinese medicinal materials, and it has a health and longevity effect. In recent years, investigations about the chemical compounds of Citrus medica L. var. sarcodactylis Swingle have shown that its main compounds include flavonoids, essential oils, coumarins, and polysaccharides, with anti-inflammatory, antimicrobial, antioxidant activities, an effect on the autonomic nervous system, and other pharmacological effects. In this paper, the chemical compositions and pharmacological effects of Citrus medica L. var. sarcodactylis Swingle are summarized.

Keywords Citrus medica L. var. sarcodactylis Swingle, chemical constituents, pharmacological effects

Introduction

Citrus medica L. var. sarcodactylis Swingle (Rutaceae), one of the variants of Citrus medica L. var. medica, is an evergreen shrub or small tree and widely cultivated in Zhejiang, Fujian, Guangdong, Guangxi, Yunnan and Sichuan Province of China. Citrus medica L. var. sarcodactylis Swingle has the function of protecting liver, stomach and pancreas, and can treat hypertension and respiratory tract infection. In addition, it is traditionally used for the treatment of hypertension, respiratory tract infections and tracheitis in China. Due to the above effects, Citrus medica L. var. sarcodactylis Swingle has gradually attracted widespread attention in recent years. Herein, we summarize the chemical constituents and pharmacological effects of Citrus medica L. var. sarcodactylis Swingle.

Chemical Constituents of Citrus medica L. var. sarcodactylis Swingle

The chemical compositions of Citrus medica L. var. sarcodactylis Swingle are reported mainly including phenolic components, terpenoids, essential oil, and other components.

Phenolic constituent

The phenolic components of Citrus medica L. var. sarcodactylis Swingle are mainly flavonoids, coumarins, and other phenolic components (Figure 1). The flavonoids are the main components in Citrus medica L. var. sarcodactylis Swingle. In 1984, He and Ling isolated two flavonoids from Citrus medica L. var. sarcodactylis Swingle, named 3,5,6-trihydroxy-4',7-dimethoxyflavone (1) and 3,5,6-trihydroxy-3',4',7'-trimethoxyflavone (2). In 2004, Feng et al. isolated diosmetin (3), and diosmin (4) from the ethanol extract of Citrus medica L. var. sarcodactylis Swingle in 2004. In 2010, Chan et al. used a combination of traditional chromatography techniques isolated atalantoflavon (5), lonchocarpol A (6), and C-glycosyllavone-vitexin (7).

Coumarins are also important phenolic compounds of Citrus medica L. var. sarcodactylis Swingle. Gao et al. isolated 5,7-dimethoxycoumarin (8) from Citrus medica L. var. sarcodactylis Swingle in 2002. In 2010, Chan et al. purified a new coumarin named citrumedin-B (9) and xanthyletin (10).

Terpenoids

The terpenoids in Citrus medica L. var. sarcodactylis Swingle are mainly triterpenoids especially tetratenor terpenoids, and sesquiterpenoids. In 2010, Chan et al. purified thirty known compounds from Citrus medica L. var. sarcodactylis Swingle by using a combination of traditional chromatography techniques, including 1→(10→19)abeo-7α-acetoxy-10β-hydroxyisobaccunoic acid-3,10-lactone (18), nomilin (19), limonin (20), lupeol...
Minireview

Figure 2 The structures of terpenoids isolated from Citrus medica L. var. sarcodactylis Swingle.

(21), limonexic acid (22), citrusin (23) (Figure 2).[6]

Then in 2017, Chan et al. found a new sesquiterpene named citrumin-C (24) by investigation of the chemical constituents from the fruits of Citrus medica L. var. sarcodactylis Swingle.[6]

Essential oil

Essential oil is an important part of the study of Citrus medica L. var. sarcodactylis Swingle. Kim et al. studied the composition of essential oil of Citrus medica L. var. sarcodactylis Swingle by GC-MS, and identified fifteen components in 2013.[9] According to their study, the main components of the essential oil of Citrus medica L. var. sarcodactylis Swingle are limonene (25) and γ-Terpinene (26) (Figure 3). Mitropoulou et al. used SPME GC-MS to analyze the main compounds of the essential oil of C. medica peels and assayed the antimicrobial properties in 2017.[10] In 2018, Guo et al. compared chemical composition, antimicrobial and antioxidant activity of essential oil from Citrus medica L. var. sarcodactylis Swingle.[11] They used GC-MS analysis for identifying more than 200 chemical components from the essential oil of Citrus medica L. var. sarcodactylis Swingle, which contained D-limonene (27), α-pinene (28), myrcene (29), ocimene (30), and linalool (31).

Figure 3 The structures of essential oil from Citrus medica L. var. sarcodactylis Swingle.

Other compounds

In addition to the above chemical components, Gao et al. isolated Δ5,20-stigmasterol (32) and palmic acid (33) from the ethyl acetate part of its ethanol extract in 2002. It is the first time Δ5,20-stigmasterol was isolated from Citrus medica L. var. sarcodactylis Swingle.[17] In 2004, Feng et al. isolated a new polysaccharide 5-methoxyfurfural and Kojic acid (34) from the ethanol extract of Citrus medica L. var. sarcodactylis Swingle.[9]

Pharmacological Activities

Citrus medica L. var. sarcodactylis Swingle is a traditional Chinese medicinal plant with a variety of pharmacological activities such as antimicrobial, anti-inflammatory, antioxidative effect, and so on.[12]

Antimicrobial activity

Theanphong et al. tested antimicrobial activity of essential oil with agar diffusion method and found its significant antimicrobial activity against S. aureus and B. subtilis with the same minimum inhibitory concentration of 2500 ppm.[13] Li et al. studied antimicrobial effect of Citrus medica L. var. sarcodactylis Swingle essential oil and its mechanism against food-borne bacteria. Then, they found that the essential oil showed a significant reduction effect on the growth rate of bacteria, and led to lysis of the cell wall, intracellular ingredient leakage, cell death eventually.[14]

Anti-inflammatory activity

Kim et al. showed that the essential oil of Citrus medica L. var. sarcodactylis Swingle inhibited LPS-stimulated inflammation by blocking the NF-κB, JNK, and ERK pathways in macrophages, and proved essential oil possessed anti-inflammatory properties.[9]

Antioxidative activity

Zhu et al. found that the bergamot polysaccharide of Citrus medica L. var. sarcodactylis Swingle could efficiently remove O₂⁻, HO⁻ and protect DNA chains significantly from being damaged by free radicals.[15]

Effect on the autonomic nervous system

Sayorwan et al. investigated the Citrus medica L. var. sarcodactylis Swingle peel oil effect on the autonomic nervous systems and mood responses after inhaling.[16]

Other pharmacological activities

Peng et al. proved that Citrus medica L. var. sarcodactylis Swingle fruit can promote insulin secretion by kinetic analysis on the hypoglycemic patterns of the intraperitoneal glucose tolerance (IPGTT) and the insulin-glucose tolerance tests (IGTT).[11]

Conclusions and Perspectives

As one traditional Chinese medicine, Citrus medica L. var. sarcodactylis Swingle is distributed widely and it has a long medicinal history. The chemical constituents of Citrus medica L. var. sarcodactylis Swingle include polysaccharide, flavonoids, essential oils, coumarins, sesquiterpene, and other compounds. Pharmacodynamic studies show that it has a variety of pharmacological effects. At present, the research on Citrus medica L. var. sarcodactylis Swingle is mainly focused on the components and functions of essential oil, its other components and bioactivities need to be further studied.

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Author Contributions

Following are the details of the contributions made by each of the authors for the manuscript: Hezhong Jiang and Shuyu Xu performed the data analyses and wrote the manuscript; Yin Qu and Xinyu Liu contributed to the conception of the study; Yao Li and Jimin Liu contributed to analysis and manuscript preparation.

Conflict of Interest

The authors declare no conflict of interest.

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