Analysis of Medicinal Value of Paulownia Flower

Hui-Yuan HUANG\textsuperscript{a}, Ming-San MIAO\textsuperscript{b,*}

Hennan University of Chinese Medicine, Zhengzhou, China 450008
\textsuperscript{a}yaolihuanghuiyuan@126.com, \textsuperscript{b}miaomingsan@163.com
*Corresponding author

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Abstract. Paulownia flower contains flavonoids, triterpenoids, volatile oils, amino acids, proteins, tannins, phenols, trace elements and has the effect of detoxification, detumescence, anti-tumor, anti-oxidation, antibacterial and enhancing immunity. It has a good therapeutic effect on upper respiratory tract infection, bacillary dysentery, bronchial pneumonia, acute tonsillitis and conjunctivitis, otitis externa. The Paulownia flower is rich in resources, low price, but the market on Paulownia flower products rarely, lead to the Paulownia flower should not be fully applied, resulting in a waste of resources. For the comprehensive utilization of Paulownia flower, the flower of Paulownia chemical composition, pharmacological effects, clinical application, literature research into Line review.

Introduction

Paulownia flowers are fresh or dried flowers of Paulownia fortunei [1]. It is mainly distributed in Hebei, Henan and other places, among which Paulownia in Lankao County of Henan Province has the fastest growth and is rich in flower resources. Paulownia flowers have a high medicinal value, can clear the lungs and pharynx, detoxification, swelling, upper respiratory tract infection, bacterial dysentery, bronchial pneumonia, acute tonsillitis, conjunctivitis, otitis externa have a good therapeutic effect. It is ancient and modern Common folk herbal medicine. Such as: Paulownia flower decoction treatment of acute cystitis. The ancient books on the medicinal value of paulownia flowers are also recorded. The Compendium of Materia Medica remarks: “Tung Yeh...Insects. The main flower is a pig sore, which causes swelling and hair growth”[2]. The Pharmaceutical Theory records: “Medicine Wulin, Mu Hair loss, nourishment.” Paulownia is one of the Chinese herbal medicines commonly used in traditional Chinese medicine. Its roots, stems, leaves and flowers can all be used as traditional Chinese medicines. In China, Paulownia is widely cultivated and its resources are very rich. In recent years, there have been great breakthroughs in the research of Paulownia's resources distribution, growth characteristics, active ingredients, pharmacological action, clinical application and so on. However, the research and utilization of Paulownia flower is lacking, and the waste is serious. According to the research, 90% of Paulownia flower resources cannot be used rationally. According to the literature, Paulownia flower contains volatile oil, flavonoids, three terpenoids and other active ingredients, and has a good anti-tumor effect, enhance immunity and so on. In order to make better use of Paulownia flower, the chemical composition, pharmacological action and clinical application of Paulownia flower are discussed in this paper, which can provide reference for the further development and utilization of Paulownia flower.
Chemical Composition

According to the present research results, the Paulownia flowers contain flavonoids, glycosides, three terpenes, volatile oil, alkaloids, organic acids, amino acids, trace elements, phenols, proteins and tannins.

Flavones

Paulownia flowers contain abundant active ingredients flavonoids. Referring to the relevant literature, it is found that the research on Flavonoids in Paulownia flowers is on the rise. In 2004, Du Xin, Li Zhigang and others used nuclear magnetic technology to study 5 kinds of flavonoids in Paulownia flowers. Summarizing the database of Chinese net and Wan Fang, Paulownia contains more than 11 kinds of flavonoids, mainly (1) rutin, (2) 5, 7, 4c- three hydroxy -3c- methoxy flavone, (3) 3c-O-methylidiplacol, (4) 3c- methoxy -7 -O -B -D- glucoside and (5) quercetin -3 -O -B-D- glucoside, (6) kaempferol -3 -O -B-D- glucoside, (7) kaempferol -7-O-B -D- glucoside, (8) luteolin, (9) apigenin [3], (10) quercetin -7-O -B-D-glucoside and (11) high North American St. With the application of ultrasonic and ultrasonic assisted extraction, polyamide column chromatography, nuclear magnetic resonance and silica gel column chromatography, more new flavonoids in Paulownia flower are gradually discovered. Flavonoids have many functions. Paulownia flowers contain many flavonoids, which is of great significance.

Three Terpenoids

Studies have shown that triterpene compounds have antibacterial, anti-tumor and viral, hypolipidemic blood glucose and other effects. Paulownia flowers contain triterpene acid active ingredients such as ursolic acid, glucoside, oleanolic acid, ursolic acid and their glycosides. Liu Lin et al. found that paulownia flower contains 0.30% ursolic acid and 0.1% oleanolic acid. Triterpenoids have remarkable pharmacological activity. In recent years, the pharmacological effects of triterpenoid compounds have been increasing dramatically. However, there are few literatures on the extraction, separation and activity of triterpene acids in paulownia flowers. Therefore, further studies on triterpene compounds in paulownia flowers will be an indispensable step for comprehensive utilization of paulownia flowers [4].

Volatile Oil

Paulownia flowers contain 67 volatile components, including esters, aldehydes, ketones, phenols, hydrocarbons, alcohols, amides, etc., of which the type of hydrocarbon is the most, and the type of amide compound is the least. Most of these substances are non-toxic and can be used as spices and medicinal materials, and have extremely high development value. Paulownia flowers in bloom contain the most aromatic oils. 100g of paulownia flowers can be obtained by steam distillation to obtain a transparent yellow volatile oil 1.16%. In addition, studies have shown that the use of GC-MS combination technology to isolate the volatile components of Paulownia flowers extracted with petroleum ether, the results obtained anisole 25.88%, 3,7,11,15-tetramethyl hexadecane-1,6,10,14-tetraen-3-ol 14.74%, 3-octanone 14.08%, tricosane 5.79%, p-methoxyanisole 12.06%, 9,19-cyclopentanene-24- The en-3-ol 5.41%, methyl chedulate 9.32%, hexadecanoic acid 5.09%, ocimene 4.34%, and hexadecylene oxirane 4.93%. There are few studies on the constituents of the volatile oil from paulownia flowers, and their pharmacological effects remain to be further studied [5].
Pharmacological Effects

Antibacterial, Anti-virus

Paulownia flowers have a certain inhibitory effect on many bacteria, especially Staphylococcus [6]. For example, flavonoids contained in Paulownia flowers can treat abdominal cavity infections caused by Staphylococcus, Salmonella pullorum, and Streptococcus pneumoniae, and its antibacterial effect is equivalent to chloramphenicol, which has a good antibacterial effect. In addition, Feng Yiping found that the paulownia flower has good antibacterial effect on Aspergillus niger and Bacillus subtilis. Aspergillus niger and Bacillus subtilis are the more common bacterial groups in food preservation. It can be seen that paulownia flower can be used as a natural food preservative. Paulownia flowers are cheap and easy to obtain and have great potential for development [7]. The apigenin contained in paulownia flowers has a unique antiviral effect. Although apigenin is one of the flavonoids, and most of the flavonoids have a wide range of biological activities, studies have shown that the structure of the orange peel and quercetin is similar to that of apigenin but has no antiviral effect. Apigenin has an antiviral effect, and it exerts an antiviral effect through a unique mechanism. However, there are few relevant literatures and studies that explore the antibacterial and antiviral effects of Paulownia flowers.

Anti-tumor

Both luteolin and ursolic acid have good antitumor effects. Hypoxylate inhibits the proliferation of malignant cells and induces apoptosis in tumor cells. Kotanidou A and other studies found that luteolin can inhibit the proliferation of more than 10 kinds of human cancer cells and induce its apoptosis. For example, liver cancer Hep G2, leiomyoma cell, melanoma cell, leukemia P388/CEM2CT/CEM227, cervical cancer Hela, gastric cancer HGC227. Ursolic acid has a good anti-cancer, immune regulation, anti-inflammatory, anti-mutagenic, anti-viral effects [8-9]. Paulownia flower is rich in luteolin and ursolic acid, so it has great research significance.

Antioxidant

The flavonoids contained in paulownia flowers have antioxidant effects. Meng Zhifen et al. found that the flavonoids contained in paulownia flower had good antioxidant activity, and its antioxidation effect was enhanced with increasing dose [10].

Enhance Immunity

The flavonoids contained in paulownia flower can enhance the body's immune function. Fu Mingzhe and other experiments show that paulownia flower flavonoids have immune effects on mice. The flavonoids contained in paulownia flower can increase the weight of mouse spleen, increase phagocytosis percentage, index and lymphoid transformation rate. Its mechanism of action is that the flavonoids contained in paulownia flowers can promote the development of immune organs, enhance the activity of phagocytic cells, and increase the phagocytic phagocytosis and lymphocyte transformation rate.

Anti-asthma and Allergic Inflammation

Paulownia flower has anti-asthmatic and allergic inflammatory reactions and can inhibit the allergic inflammatory reaction of asthma. Li Xiaochao studied the effects of paulownia flower
volatile oil on asthma in guinea pigs. The results showed that the volatile oil of paulownia flower can inhibit the expression of inflammatory factors and eosinophil chemokines, and has a significant anti-asthmatic and allergic inflammatory response [11]. Chen Baohong et al studied the effect of paulownia flowers on ovalbumin-induced asthma in guinea pigs and found that paulownia flowers can prolong the incubation period of asthma in guinea pigs, inhibit the total number of eosinophils and white blood cells in different degrees, and eosinophil chemotaxis in airway epithelium. The overexpression of factors inhibits the accumulation of eosinophils in the airways of asthma and inhibits airway inflammation.

**Insecticide**

According to foreign reports, paulownia flowers have a good insecticidal effect. Paulownia in paulownia flowers can enhance the insecticidal effect of the insecticide pyrethrum and can effectively kill mosquitoes, flies and their larvae. Therefore, paulownia flowers can be used to develop insecticides [12].

**Non-toxic**

Paulownia flowers are non-toxic and a safe drug. The related literature found that rabbits were given paulownia flower extracts. There was no significant change in the appetite, body weight, and white blood cell count of rabbits. Oral paulownia flower extract and intramuscular paulownia flower injection for adults. There was no significant change in the number of white blood cells, body temperature, pulse, etc. [13]. It proved that Paulownia flowers are non-toxic.

**Clinical Application**

**Ancient Application**

The roots, stems, leaves, and flowers of Paulownia can be used as herbal medicines and are often used to treat inflammation and infectious diseases. Folks often use fresh crushed paulownia flowers on their faces to treat acne. Paulownia flower has the function of Qingfei Liyan, detoxification and swelling, and can be used for hyperactivity cough, acute enteritis, mumps and so on. *Henan Chinese Herbal Medicine Handbook* records “the treatment of mumps, paulownia spent eight money. Decoction, sugar one or two blunt.” In addition, paulownia flowers can be used as feed additives. *Compendium of Materia Medica* remarked that “budding...and pigs are three times more fat” [14].

**Modern Applications**

Paulownia flowers are used to treat skin blister, herpes, hand-foot-mouth disease and other diseases. Enterovirus 71 (EV71) and Coxsackievirus A16 are the main treatment factors for HFMD. Enterovirus 71 is an RNA virus that contains IRES (ribosome entry site) in the genome that interacts with hnRNPs (nuclear heterogeneous ribonucleoproteins) to regulate viral transcription. Studies have shown that when enterovirus 71 RNA and hnRNAPA1A2 bind to each other, they can be destroyed by apigenin, a flavonoid contained in paulownia flowers, and inhibit EV71 infection [15]. Paulownia flowers have protective effects on acute liver injury caused by CCl4. Liu Xingxia and other [16] studies have shown that paulownia flowers can reduce ALT, AST and MDA levels in liver tissue and increase SOD in mouse serum. In addition, the volatile oil contained in paulownia flower can inhibit the expression of Eotaxin, clear the Eos accumulated in the trachea, reduce the inflammatory reaction, and treat asthma.
For example, paulownia flower extract also has a protective effect on allergic asthma. Paulownia flowers can significantly reduce the number of eosinophils in bronchial mucosa, inhibit the infiltration of inflammatory cells, and reduce bronchial smooth muscle proliferation [17]. The effect of syringin in Paulownia has the effect of hemostasis. Clinically, Paulownia can be injected with syringin for surgery. Paulownia flowers can also be used to treat burns. In 2005, Zuo Jinjing’s research showed that paulownia sinensis has good therapeutic effects on degree I degree II burns. It can be made into injections, tablets, ointments, water and other formulations. *Henan Chinese Herbal Medicine Handbook* records that 224 cases of 16 diseases have certain effects. It is very important to make rational use of Paulownia flowers.

**Application and Analysis of Paulownia Flowers in CNKI Literature**

Searching for the theme word Paulownia flower through CNKI search showed that there were 67 articles about Paulownia flowers in the past ten years (2017 -2010). There were only 1 articles on the clinical application of Paulownia flower, accounting for 1.5%. 0 articles related to Paulownia flower toxicity. 12 literature of Paulownia flower chemical composition, 17.9%. Only 2 articles related to Paulownia flower pharmacological action, accounting for 3%. There are only 3 literatures related to the active substances of paulownia flowers that play a role in efficacy, accounting for 4.5%. There are 2 articles on the identification of Paulownia and peanuts, accounting for 3.0%. Literature on brass compounds belonging to Paulownia flower active ingredients 20 Articles, accounting for 29.9%. 2 studies on the volatile substances of Paulownia flowers, accounting for 3.0%. 1 literature on the nutritional content of Paulownia flowers, accounting for 1.5%. 15 articles on the extraction of Paulownia flowers, accounting for 22.4%. 3 articles on the quality of Paulownia flowers, accounting for 4.5%. See Table 1.

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<th>Type</th>
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There are many researches on paulownia flower extraction technology, including steam distillation, ethanol extraction, petroleum ether extraction, ultrasonic method, ultrasound-assisted extraction, liquid chromatography, and GC-MS. However, there are few researches on clinical application and pharmacological effects and it needs further study.

**Prospect**

Paulownia flowers symplectic, bitter, micro cold, into the lung liver, contains flavonoids, three terpenes, volatile oil, alkaloids, organic acids, amino acids, trace elements, phenols, protein and tannin chemical components. It has the functions of dispersing wind and dissipating heat, clearing away heat and detoxicating, clearing liver and improving eyesight, drying dampness and stopping disease, antibacterial, anti-tumor, antioxidation and enhancing immunity. The paulownia flower is rich in resources, and it is used clinically for the treatment
of exogenous fever and early onset of cough, sore throat, swollen eyes and throat caused by liver fire attack, abdominal pain, sepsis, upper respiratory tract infection, bacterial dysentery, and bronchopneumonia. Acute tonsillitis and conjunctivitis, otitis externa. The paulownia flower contains anti-oxidant ingredients that delay skin aging and can be applied to the beauty field. Fresh paulownia flowers smashing and covering your face can eliminate acne. Paulownia can kill insects and can be used as an insecticide in agriculture. Paulownia flower contains a variety of amino acids, it has a very broad application prospect as animal feed [18].

Paulownia flowers are widely used. There are a large number of plantings in Lankao County of our province, and they are rich in resources. It is recommended that they be incorporated into the local standards of Henan Province and be fully utilized. In addition, pharmacological effects should be studied when extracting and separating the compounds from paulownia flowers. Clinical research and application of active substances should be increased to provide more effective drugs for the treatment of diseases. To research and develop clinically relevant new drugs and new formulations of paulownia flowers, expand the application of paulownia flowers in diseases, and explore the various uses of paulownia flowers, such as external treatment. The paulownia flower is applied to many fields such as medical treatment, health care, cosmetics, and agriculture, and the paulownia flower resources are comprehensively developed and utilized.

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Corresponding author: Miao Mingsan, male professors, Ph.D., Pharmacology mainly engaged in teaching and research. Email: miaomingsan@163.com.
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