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Review

Platycodon grandiflorus – An Ethnopharmacological, phytochemical and pharmacological review

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luteolin-7-*O*-glucoside (Pubchem CID: 5280637)
apigenin-7-*O*-glucoside (Pubchem CID: 5280704)
luteolin (Pubchem CID: 5280445)
apigenin (Pubchem CID: 5280443)
palmitic acid (Pubchem CID: 985)
oleic acid (Pubchem CID: 445639)
caffeic acid (Pubchem CID: 689043)
ferulic acid (Pubchem CID: 445858)
isoferulic acid (Pubchem CID: 736186)
m-coumaric acid (Pubchem CID: 71310991)
p-coumaric acid (Pubchem CID: 637542)
p-hydroxybenzoic acid (Pubchem CID: 176323540)
α-resorcylic acid (Pubchem CID: 7424)
2,3-dihydroxybenzoic acid (Pubchem CID:

ABSTRACT

Ethnopharmacological relevance: Platycodon grandiflorus (Jacq.) A. DC., the sole species in genus *Platycodon* A. DC. (Campanulaceae) has a long history of use as a traditional herbal medicine for the treatments of cough, phlegm, sore throat, lung abscess, chest pain, dysuria, and dysentery. As a legal medicine and dietary supplement, it is also frequently used as an ingredient in health foods and vegetable dishes. The aim of this review is to provide up-to-date information on the botanical characterization and distribution, ethnopharmacology, phytochemistry, pharmacology, and toxicity of *Platycodon grandiflorus* based on literature published in recent years. It will build a foundation for further study of the mechanism of action and the development of better therapeutic agents and healthy products from *Platycodon grandiflorus*.

Material and methods: All of the available information on *Platycodon grandiflorus* was collected via electronic search (using PubMed, SciFinder Scholar, CNKI, TPL (www.theplantlist.org), Google Scholar, Baidu Scholar, and Web of Science).

Results: A comprehensive analysis of the literature obtained through the above-mentioned sources confirmed that ethno-medical uses of *Platycodon grandiflorus* have been recorded in China, Japan, Mongolia, and Korea for thousands of years. A phytochemical investigation revealed that this product contains steroidal saponins, flavonoids, polyacetylenes, sterols, phenolics, and other bioactive compounds. Crude extracts and pure compounds isolated from *Platycodon grandiflorus* exhibited significant anti-inflammatory and immunostimulatory effects. They also showed valuable bioactive effects, such as anti-tumor, anti-oxidant, anti-diabetic, anti-obesity, hepatoprotective and cardiovascular system effects, among others.

Conclusions: In light of its long traditional use and the modern phytochemical and pharmacological studies summarized here, *Platycodon grandiflorus* has been demonstrated to show a strong potential for therapeutic and health-maintaining uses. Both the extracts and chemical components isolated from the plant showed a wide range of biological activities. Thus, more studies on the pharmacological mechanisms of its main active compounds (e.g., platycodin D, D_2) need to be conducted. In addition, as one of the most popular traditional herbal medicines, clinical studies of the main therapeutic aspects, toxicity and adverse effects of *Platycodon grandiflorus* will also undoubtedly be the focus of future investigation.

Abbreviations: A549, adenocarcinoma cells; AP-1, activator protein 1; APAP, acetaminophen; BHT, butylated hydroxytoluene; BHA, butyl hydroxy anisd; CK, the aqueous extract from the root of *Platycodon grandiflorus* (Changkil); CKS, the saponins from the root of *Platycodon grandiflorus* (Changkil saponins); COX-2, cyclooxygenase-2; CYP2E1, cytochrome P450 2E1; DPPH, 1,1-diphenyl-2-picrylhydrazyl; FABP-4, fatty acid binding protein-4; HD50, 50% of the maximum hemolysis; HDL, high-density lipoprotein; hTERT, human telomerase reverse transcriptase; iNOS, inducible NO synthase; ISI, insulin sensitivity index; KLF-2, kruppel-like factor 2; LDL, low density lipoprotein; LPS, lipopolysaccharide; MAPK, mitogen-activated protein kinase; MCP-1, monocyte chemotactic protein 1; MMP, matrix metalloproteinases; NS, serum insulin levels; OVA, ovalbumin; IP, peritoneal injection; PG, polysaccharides isolated from the radix of *Platycodon grandiflorus*; PGS, *Platycodon grandiflorus* saponin; PGSC, *Platycodon grandiflorus* saponin C; PGSD, *Platycodon grandiflorus* saponin D; PKC, protein kinase C; PGE, *Platycodon grandiflorus* alcohol extract; PPAR, peroxisome proliferator-activated receptor; ROS, reactive oxygen species; *t*-BHP, *tert*-butyl hydroperoxide; TC, total cholesterol; Th, T helper cells; Th1, T helper cell type1; Th2, T helper cells type2; TG, triglyceride; TNF-α, tumor necrosis factor-α

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homovanillic acid (Pubchem CID: 1738)
chlorogenic acid (Pubchem CID: 1794427)
lobetyol (Pubchem CID: 372975)
lobetyolin (Pubchem CID: 6369123)
lobetyolinin (Pubchem CID: 5459227)
spinasterol (Pubchem CID: 5281331)
betulin (Pubchem CID: 72326)
β-sitosterol (Pubchem CID: 222284)
δ-7-stigmastenone-3 (Pubchem CID: 5748344)
platycodin D (Pubchem CID: 162859)
platycodin D_2 (Pubchem CID: 53317652)
platycodin C (Pubchem CID: 46173919)
and platycodin A (Pubchem CID: 46173910)

Contents

1. Introduction

Platycodon grandiflorus (Jacq.) A. DC., the sole species in genus *Platycodon* (Campanulaceae) (Zhou, 1994), is mainly distributed in Northeast Asia. Platycodon Rhizoma, the rhizomes of *Platycodon grandiflorus* (Committee for the Pharmacopoeia of PR China, 2005), are known as *Jiegeng* (桔梗) or *Lingdanghua* in China, *Doraji* in North Korea, *Kikyo* in Japan and *Huridunzhaga* in Mongolia.

As a traditional herbal medicine, *Platycodon grandiflorus* has been widely used in Northeast Asia (including China, Japan, and Korea.) for the treatment of cough, excessive phlegm, and sore throat, among other ailments (Committee for the Pharmacopoeia of PR China, 2005). In addition, *Platycodon grandiflorus* also displays significant effects on the cardiovascular and metabolic systems (Fu et al., 2006a). In recent decades, investigations of *Platycodon grandiflorus* have focused on its biological activities, including its anti-tumor, hepatoprotective, immunoregulatory, and anti-oxidant effects. These studies have resulted in the isolation of saponins, flavonoids, anthocyanins, phenolics, and polysaccharides, among other compounds, from the plant.

This review intends to provide a comprehensive insight into the botanical characterization, distribution, ethnopharmacology, phytochemistry, pharmacology, and toxicity of *Platycodon grandiflorus* based on scientific literatures in recent years. This study will build a new foundation for further study on the mechanism of action of and development of better therapeutic agents and healthy products from *Platycodon grandiflorus*.

2. Botanical characterization and distribution

As a perennial herb, *Platycodon grandiflorus* grows to the height of 20–120 cm. The stem is simple, rarely branched, usually glabrous, and rarely densely puberulent. Leaves are adaxially green, ovate, elliptic, or lanceolate, 2–7 × 0.5–3.5 cm^2. Its flower is blue or purple, ranging in size from 1.5–4.5 cm^2 (Fig. 1B). It blossoms from July to September and fruits from August to October (Huang, 2008). The roots and rhizomes of *Platycodon grandiflorus* are always harvested in August due to their important role as a folk medicine and food resource (Fig. 1A).

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