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Review

Sophora flavescens Ait.: Traditional usage, phytochemistry and pharmacology of an important traditional Chinese medicine

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ABSTRACT

Ethnopharmacological relevance: *Sophora flavescens* (Fabaceae), also known as Kushen (Chinese: 苦参), has been an important species in Chinese medicine since the Qin and Han dynasties. The root of *Sophora flavescens* has a long history in the traditional medicine of many countries, including China, Japan, Korea, India and some countries in Europe. In traditional Chinese medicine (TCM), *Sophora flavescens* has been used extensively, mainly in combination with other medicinal plants in prescriptions to treat fever, dysentery, hemochoezia, jaundice, oliguria, vulvar swelling, asthma, eczema, inflammatory disorders, ulcers and diseases associated with skin burns. The aim of this review is to provide updated and comprehensive information regarding the botany, ethnopharmacology, phytochemistry, biological activities and toxicology of *Sophora flavescens* and to discuss possible trends and opportunities for further research on *Sophora flavescens*.

Materials and methods: We systematically searched major scientific databases (PubMed, Elsevier, SpringerLink, Google Scholar, Medline Plus, ACS, "Da Yi Yi Xue Sou Suo (<http://www.dayi100.com/login.jsp>)", China Knowledge Resource Integrated (CNKI) and Web of Science) for information published between 1958 and 2015 on *Sophora flavescens*. Information was also acquired from local classic herbal literature, conference papers, government reports, and PhD and MSc dissertations.

Results: The broad spectrum of biological activities associated with *Sophora flavescens* has been considered a valuable resource in both traditional and modern medicine. Extracts are taken either orally or by injection. More than 200 compounds have been isolated from *Sophora flavescens*, and the major components have been identified as flavonoids and alkaloids. Recent *in vitro* and *in vivo* studies indicate that at least 50 pure compounds and crude extracts from *Sophora flavescens* possess wide-ranging antitumor, antimicrobial, antipyretic, antinociceptive, and anti-inflammatory pharmacological abilities. The anticancer and anti-infection abilities of these components are especially attractive areas for research.

Conclusions: *Sophora flavescens* is a promising traditional medicine, but there is a need for more precise studies to test the safety and clinical value of its main active crude extracts and pure compounds and to clarify their mechanisms of action. Moreover, some existing studies have lacked systematic methods and

Abbreviations: 5-HT, 5-hydroxytryptamine; 5R-DHT, 5R-dihydrotestosterone; Ach, Acetylcholine; AGE, Advanced glycation end product; AHR, Airway hyperreactivity; ALP, Alkaline phosphatase; ANP, Atrial natriuretic peptide; DGAT, Diacylglycerol acyltransferase; DHT, Dihydrotestosterone; DNFB, 1-Fluoro-2,4-dinitrofluorobenzene; EC₅₀, Concentration for 50% of maximal effect; ECA, Ehrlich ascites carcinoma cell lines; Eca-109, Human esophageal squamous carcinoma Eca-109 cell line; ER, Estrogen receptor; ERK, Extracellular regulated protein kinases; EtOAc, Ethyl acetate; H460, Non-small cell lung cancer H460; HBeAg, Hepatitis B e antigen; HBsAg, Hepatitis B surface antigen; HBV, Viral hepatitis type B; HDL-C, High-density lipoprotein-cholesterol; HMC-1, Human mast cell-1; HPLC, High performance liquid chromatography; HPLC-DAD-ESI/MS, High performance liquid chromatography with diode-array detector and electrospray ionization-tandem mass spectrometry; HRAR, Human recombinant aldose reductase; HSV, Herpes simplex virus; HT29, Colon cancer cell line; IC₅₀, 50% inhibition concentration; IGF-1, Insulin and insulin-like growth factor-1; IL, Interleukin; IFN- γ , Interferon-gamma; iNOS, Inducible nitric oxide synthase; KGF, Kinetics gain factor; LD₅₀, Median lethal dose; LDL-C, Low-density lipoprotein-cholesterol; LH, Luteinizing hormone; LPS, Lipopolysaccharide; LVSP, Left ventricular systolic pressure; LVEDP, Left ventricular end-diastolic pressure; MAO, Monoamine oxidase; MC3T3-E1, Murine calvaria-derived osteoblastic cell line; MCF-7, Human breast adenocarcinoma cell lines; MCP-1, Monocyte chemoattractant protein-1; MDA, Malondialdehyde; MIC, Minimal inhibitory concentration; MTT, Methylthiazolylidiphenyl-tetrazolium bromide; NF- κ B, Nuclear factor kappa B; NO, Nitric oxide; PDE, Phosphodiesterase; PFS, Prenylated flavonoid-enriched fraction; PGE₂, Prostaglandin E₂; PMA, Phorbol 12-myristate 13-acetate; PPARs, Peroxisome proliferator-activated receptors; RANKL, Receptor activator for nuclear factor- κ B ligand; RLAR, Rat lens aldose reductase; ROS, Reactive oxygen species; S180, Sarcoma 180; SFE, *Sophora flavescens* extract; SFL, Lectin from *Sophora flavescens*; sGC-cGMP, Soluble guanylyl cyclase-cyclic guanosine monophosphate; SGLT, Na⁺-glucose cotransporter; SOD, Superoxide dismutase; SR, Root of *Sophora flavescens*; TC, Total cholesterol; TCM, Traditional Chinese Medicine; TG, Triglycerides; TLC, Thin layer chromatography; TNF- α , Tumor necrosis factor-alpha

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integration with the existing literature, and some of the experiments were isolated, used small sample sizes and were unreliable. More validated data are therefore required.

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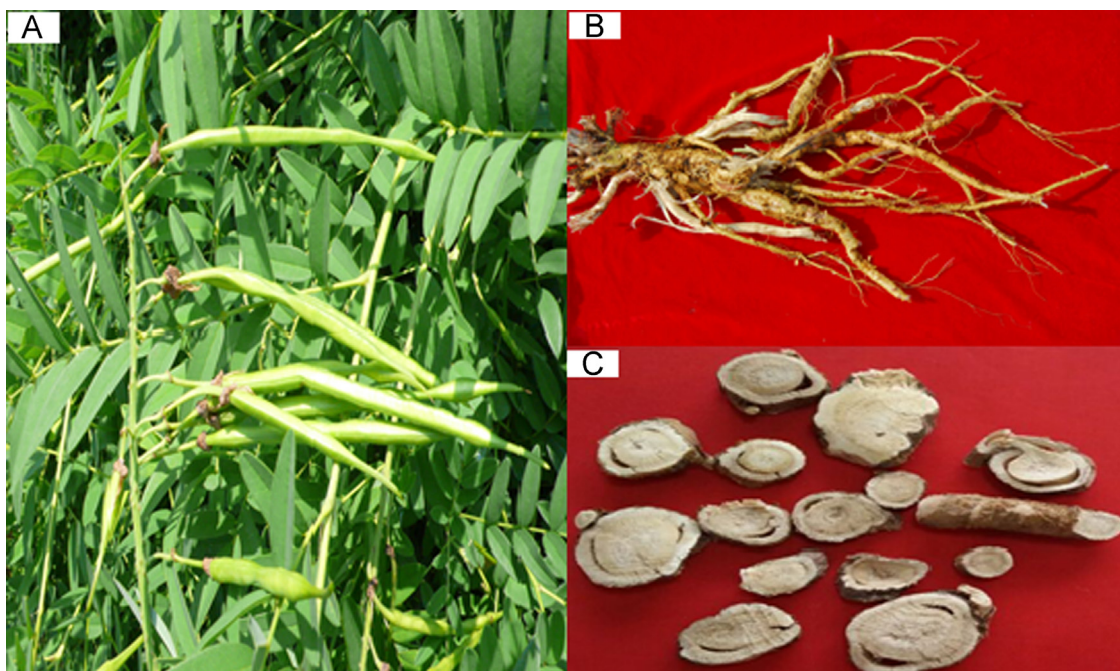


Fig. 1. *Sophora flavescens* Ait. (A) the aerial parts, (B) roots, and (C) traditional Chinese medicine decoction pieces.

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