Pharmacogn. Res., 2025; 17(4):1-10.
https://www.phcogres.com

Review Article

Critical Review on Phytoconstituents and Pharmacological Activity of *Glycyrrhiza Glabra*

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ABSTRACT

For a very long time, plants have been used extensively to treat both humans and animals. Herbal medications, health products, and pharmaceuticals are in greater demand. A small perennial herb in the Fabaceae/Leguminosae family, Licorice is scientifically known as *Glycyrrhiza glabra*. The plant is widely recognized for having a sweet taste. The Plant's sweetness is imparted by a substance called glycyrrhizin. *Glycyrrhiza glabra* is composed of various compounds such as isoliquiritin, glycyrrhizin acid, isoflavones, and glycyrrhizin. Numerous pharmacological actions have been documented for these substances, such as expectorant, anticancer, antiulcer, demulcent, antidiabetic, and anti-inflammatory effects. Historically, licorice has been used to cure a variety of ailments, such as epilepsy, hyperdipsia, fever, stomach ulcers, rheumatism, respiratory conditions, jaundice, hemorrhagic diseases, paralysis, skin conditions, and sexual debility. Additionally, it has been used as an anti-inflammatory during allergic reactions and as a preventative measure against gastric and duodenal ulcers. These properties make *Glycyrrhiza glabra* a promising candidate for future drug development. Its potential therapeutic benefits and safety profile, however, require further study.

Keywords: *Glycyrrhiza glabra*, Licorice, Glycyrrhizin, Expectorant, Anti-inflammatory, Antiulcer.

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Received: x-x-x;
Revised: x-x-x;
Accepted: x-x-x.

INTRODUCTION

Over 75 to 80% of the world's population, mostly in developing countries, still receives primary healthcare mostly from herbal medicine because of its enhanced body compatibility, decreased side effects, and increased cultural acceptability. Herbal medicines are sold in India for about $1 billion, on the other hand, crude plant-based medications are exported for about $80 million. Herbal remedies can also be found in the nutraceutical (health food) business, currently valued between $80 and $250 billion in the USA and Europe. Ancient literature also discusses herbal remedies for age-related illnesses such as liver and immune system disorders, memory loss, osteoporosis, diabetic wounds, and others for whom there is only palliative treatment or no access to modern medicine. The raw materials used to make these medications are sourced from renewable resources and processed using environmentally responsible methods, which will benefit the public financially.[1] One commonly used herb is *Glycyrrhiza glabra* Linn. (Family: Fabaceae) is used in traditional medicine worldwide due to its ethnopharmacological efficacy in the treatment of a variety of illnesses. The rhizomes and roots of licorice are its main medicinal constituents. Growing in northern India, *Glycyrrhiza glabra* Linn., sometimes called Mulethi or Licorice, is a native of Asia and the Mediterranean. The ancient Greek terms "rhiza," which means root, and "glykos," which means sweet, are the source of the word "glycyrrhiza". This plant's sweetness makes it a popular flavouring ingredient.[2] Licorice was widely used by the ancient Greeks, Romans, and Egyptians. Since "code Humnubari" (2100 B.C.), it has been utilized in medicine. It was among the important plants that existed in the year 2000 B. C. listed as an Assyrian herb. Hippocrates (d. 400 B. C. explained how it can be used as a third-party quencher and as a remedy for ulcers. It was mentioned by both Dioscorides and Theophrastus. Traditional Siddha medicine employs licorice for laxative, expectorant, demulcent, anti-tussive, and sweetening purposes.[3] *Glycyrrhiza glabra's* leaves, flowers, roots, and powder are used for herbal and medical uses.

(Figure 1) *Glycyrrhiza* species are useful for treating a range of pathological disorders. In traditional medicine, they are recommended for coughs, colds, and painful swellings. They are also used as a diuretic and pesticide. Several conventional healers who have studied the plant have said as much.[4] Due to its medicinal qualities, particularly its ability to raise blood pressure and function as an expectorant, Licorice is a popular dietary supplement that is used as a component in herbal infusions in the form of Licorice root. A derivative product called Licorice extract is made by first slicing the roots and then extracting them

OPEN ACCESS

Manuscript TECHNOMEDIA

DOI: 10.5530/pres.20252181

Publishing Partner : Manuscript Technomedia. [www.mstechnomedia.com]

with water, then concentrating the mixture. This chemical has extensive application in the food business as a flavouring and sweetening agent in several sectors, including beverages and confections.[5] Italy, France, Germany, China, Russia, the UK, the USA, China, Northern India (Punjab and Sub-Himalayan tracts), Syria, Northern India, China, Pakistan, Russia, Afghanistan, and Southern Europe are among the countries where this plant is grown commercially. Sicily, England, and Spain are also noted for their extensive cultivation.[6] Important bioactive substances like glycyrrhizin, liquiritin, and glabridin, which are found in liquorice (*Glycyrrhiza* spp.), in the treatment of a number of illnesses. These substances support its therapeutic benefits in the treatment of respiratory, digestive, and inflammatory conditions (Figure 2).

The perennial herb *Glycyrrhiza glabra* can reach a height of 2.5 meters. Four to seven pairs of lanceolate, elliptical, or oblong leaflets make up each of the compound, imparipinnate, alternating leaves. *Glycyrrhiza glabra's* taxonomical classification emphasises its botanical identity and significance in herbal and therapeutic uses (Table 1). The fruit is an erect, glabrous, compressed legume or pod with a few reticulate pits; the calyx is short, campanulate, glandular, hair-bearing, with lanceolate ends. The flowers are thin, usually papilionaceous, lavender to violet in colour, and borne in axillary spikes. It can reach a length of up to 1.5 cm. It usually contains three to five reniform, brown seeds. The taproot of the root system has a bright yellow interior and is delicate and fibrous. *Glycyrrhiza glabra* is known by a variety of colloquial names in different places (Table 2). In areas with access to water, such as those near rivers or streams, licorice grows well in sandy, clay, or fertile soil.[7]

CHEMICAL CONSTITUENTS

The nutritional makeup of *Glycyrrhiza glabra*. Licorice contains a variety of nutrients, including proteins, polysaccharides, amino acids, resins, sterols, simple sugars, fiber, gums, and mineral salts (such as iron, silicon, magnesium, manganese, calcium, sodium, phosphorus, selenium, potassium, copper, and zinc). The following substances have been reported to be present: tannins, coumarins, vitamins B1, B2, B3, B5, E, and C, glycosides, estrogens, and phytosterols (sitosterol and stigmasterol).[10] *Glycyrrhiza glabra* Linn's roots are a rich source of active ingredients, such as saponins like Glycyrrhizin (which is 60 times sugary than sugarcane) and flavonoids like liquiritin, isoliquiritin, Liquiritigenin, glucoliquiritin, shinpterocarpin, shinflavone, apioside, 1-metho-xyphaseolin, rhamnolipids, isoflavone, coumarin-GU-12, Pyranocoumarin, and Licoarylcoumarin.[11] In addition, there have been reports of kanzonol R, a derivative of prenylated isoflavone. Four isoprenoid-substituted phenolic components (isoangustone A, semilicoisoflavone B, licoriphenone, and 1-methoxyficifolinol) and several volatile compounds, such as geraniol, α terpineol, tetramethyl pyrazine, terpinen-4-ol, linalool oxides A and B, and many others. Maltol, methyl ethyl ketone, trimethyl pyrazine, ethyl linoleate, benzoic acid, 1-methyl-2-formylpyrrole, propionic acid, and furfuryl formate were separated from the essential oil.[12] In licorice root extract, glycyrrhizin-also known as glycyrrhizic acid or glycyrrhizinate-makes up roughly 10-25% and is thought to be the main active component. Glycyrrhetinic acid, sometimes referred to as enoxolone or glycyrrhizic acid, is a triterpenoid aglycone that forms glycyrrhizin, a saponin molecule when it conjugates with a glucuronic acid disaccharide. The 18α and 18β stereoisomers of glycyrrhizin and glycyrrhizic acid are both possible. Glycyrrhizin, a tribasic acid, is found naturally in Licorice root in the forms of potassium and calcium salts. It can create a wide range of salts. The ammoniated salt produced by Glycyrrhizin from licorice extracts and used as a food flavouring agent must adhere to the Food Chemicals Codex.

An analogue of glycyrrhizic acid, carbazole (18-βglycyrrhetinic acid hydrogen succinate) is used to treat gastrointestinal tract ulcerative disorders such peptic ulcers.[13] Liquiritin, isoliquiritin (a chalcone), and other flavonoid combinations give licorice its yellow colour.[14] Tea and raw licorice infusions contain minerals (calcium, phosphorus, sodium, potassium, zinc, and copper), fiber, raw ash, moisture, fat, protein, carbohydrates, silica, and amino acids (valine, aspartic, glycine, glutamic, threonine, serine, proline alanine, isoleucine, tyrosine, leucine, lysine, phenylalanine, tyrosine, and histidine). Several organic acids, including butyric, citric, fumaric, propanoic, acetic, and tartaric acids, were discovered to be present in the methanolic extract of licorice after an HPLC analysis.[15]

TRADITIONAL USES

Licorice has been suggested in conventional medicine as a preventive measure against duodenal and stomach ulcers. It is used to treat dyspepsia by acting as an anti-inflammatory during allergic reactions.[16] Folk therapy uses it as an antiviral, emmenagogue, contraceptive, laxative, and galactagogue.[17] *Glycyrrhiza* roots have expectorant and demulcent qualities that make them beneficial for cough treatment.[18] Additionally, it works well against gout, anemia, tonsillitis, sore throats, flatulence, hyperplasia, fever, skin conditions, and swellings. Numerous ailments, such as leukorrhea, hemorrhage, bronchitis, hiccups, diarrhoea, jaundice, hoarseness, fever with delirium, and anuria, can be effectively treated with Licorice. It is a crucial part of therapeutic oils used to treat hemorrhagic diseases, rheumatism, paralysis, and epilepsy.[19] Numerous studies conducted over the years have demonstrated that glycyrrhizin acts as an anti-inflammatory agent in the stomach, much like hydrocortisone and other corticosteroid hormones. This is caused by the adrenal glands producing more hormones and the liver and kidneys breaking down less steroids. Glycyrrhizin has proven to be beneficial in treating chronic hepatitis and liver cirrhosis.

Because *Glycyrrhiza glabra* removes the irritating effect of acids more effectively than alkalis, it is one of the finest cures for pain, discomfort, and other stomach ailments.[20] The root extract has been shown to have estrogenic properties and is effective in managing menopausal symptoms, controlling menstruation, and easing cramping during the menstrual cycle. Since ancient times,*Glycyrrhiza glabra* has been used in medicine to treat liver issues. It is frequently found in polyherbal preparations meant to treat hepatotoxicity.[21] In India, anemia is treated with licorice powder and honey, glycyrrhiza root extract is applied topically as an eye drop for conjunctivitis, and licorice and Santalum album powder combined with milk is applied topically for hemoglobinemia. *Glycyrrhiza* and *Picrorhiza kurroa* paste is used as a cardiotonic.[22]

MECHANISM OF ACTION

Hepatitis A and C are among the RNA and DNA viruses that glycyrrhizic acid and glycyrrhizin have been shown to inhibit in terms of proliferation and cytopathology.[23] These actions are one of the several processes responsible for the therapeutic effects of *Glycyrrhiza glabra* against herpes zoster,[24] HIV,[25] Simplex herpes.[26] Glycyrrhizin and its metabolites suppress 5-(beta)-reductase and inhibit the hepatic metabolism of aldosterone, which are the causes of the well-known pseudo-aldosterone syndrome. Glycyrrhizic acid's mineral-corticoid and glucocorticoid activity can be attributed to structural similarities between the acid and hormones released by the adrenal cortex.[27] Constituents of *Glycyrrhiza glabra* also have anti-inflammatory properties akin to those of steroids, namely hydrocortisone. One of the factors contributing to this is the inhibition of phospholipase A2, an enzyme implicated in a number of inflammatory processes. Furthermore, studies conducted *in vitro* have shown that glycyrrhizic acid reduces the production of prostaglandins and cyclooxygenase activity, which are all involved in the inflammatory process. It also indirectly inhibits platelet aggregation. Important hepatoprotective and antioxidant qualities are seen in Licorice components. Both glabridin and glycyrrhizin prevent neutrophils at the site of inflammation from producing Reactive Oxygen Species (ROS).[28] Studies conducted *in vitro* have shown that Licorice isoflavones, hispaglabridin A & B, prevent rat liver cells (Fe.sup.3)-induced mitochondrial lipid peroxidation. Additional studies show that in animal models of ischemia-induced liver damage, glycyrrhizin reduces lipid peroxide levels. Reperfusion[29] Constituents of *Glycyrrhiza glabra* also show hepatoprotective effects by reducing tissue pathology in hepatitis patients and lowering serum liver enzyme levels.[30]

PHARMACOLOGICAL ACTIVITIES

Antioxidant Activity

One of the many uses for *Glycyrrhiza glabra* is its antioxidant properties. The phenolic content is most likely what causes the significant antioxidant activity observed,[41,44] linked flavonoids and isoflavones, including 3′-hydroxy 4-O methyl glabridin, glabridin, and hispaglabridin A, to this action. Biondi *et al*[45] discovered that the dihydro stilbene derivatives present in the leaves of *Glycyrrhiza glabra* exhibit a notable level of antioxidant activity. Furthermore, *Glycyrrhiza glabra* contains Licochalcone B and D, which have the capacity to inhibit microsomal lipid peroxidation and have a strong DPPH radical scavenging potential. Because licorice extract has a high antioxidant content, it can prevent oxidative stress damage and maintain skin homeostasis when applied topically. This makes it a valuable ingredient in novel dermal and cosmetic products. These phenolic compounds can prevent the start of skin damage and effectively shield biological systems from oxidative stress (Table 3).[46]

Immunomodulatory Activity

Swine flu is a respiratory disease that is extremely contagious and can kill 1-4% of pigs. It is species-specific and typically happens once a year, peaking in temperate climates in the fall and winter. Among these is the influenza A H1N1 virus, which has proliferated among humans and has the capacity to transcend species boundaries, meaning it can infect people from pigs. *Glycyrrhiza glabra* polysaccharide components activate macrophages and enhance and support immunological activation.[47] An analog of glycyrrhizin with promise for *in vitro* immune stimulation is the N-acetylmuramyl peptide. Furthermore, studies conducted on animals have demonstrated that it works against the influenza virus by preventing viral replication.[48] The plant's glycyrrhizic acid inhibits the multiplication of viruses, renders virus particles inactive, and may be a source of immunomodulators.[49]

Anti-inflammatory Activity

According to reports, the anti-inflammatory properties of glycyrrhetinic acid in Licorice extract are comparable to those of glucocorticoids and mineralocorticoids. For more than 2,000 years, it has been recognized that extract from Licorice root (*Glycyrrhiza*) aids in the healing of oral and stomach ulcers. Studies show that glycyrrhizin acid suppresses every inflammatory component. It prevents prostaglandin synthesis and cyclooxygenase activity. It is also in charge of the indirect inhibition of platelet aggregation.[50]

Table 1: Taxonomical Classification.[8]

Kingdom	Plantae
Class	*Dicotyledonae*
Subclass	*Magnoliidae*
Order	*Rosales*
Superorder	*Rosanne*
Family	*Leguminosae*
Genus	*Glycyrrhiza*
Species	*glabra* Linn.

Anti-viral Activity

According to reports, Licorice extract prevents the formation of certain viruses, such as type A influenza virus, vesicular stomatitis virus, Japanese encephalitis, herpes simplex, and varicella zoster. The virus cannot bind to a cell when glycyrrhizin is present. It is discovered to have strong antiviral action as a result.[51]

Antiulcer Activity

Since the early 1970s, licorice has been utilized as an antiulcer agent. Effective treatment for ulcers typically involves the use of DGL (deglycyrrhizinated licorice), which is glycyrrhizin that has been removed. Licorice roots contain a compound called carbenoxolone, which inhibits the release of gastrin and has an antiulcerogenic action.[52] Liquorice can raise prostaglandin levels in the digestive tract, which stimulates mucus secretion from the stomach. Additionally, licorice has been found to have an antipepsin effect and lengthen the life of stomach surface cells.[53]

Hepatoprotective Activity

Cirrhosis, which can result in severe hepatocellular carcinoma or possibly liver failure, is a condition that chronic hepatitis can cause.[54] For more than 50 years, people with chronic hepatitis have been treated with glycyrrhiza. It has demonstrated decreased serum aminotransferases and improved liver histology in a lab experiment when compared to a placebo. Swiss albino mice's liver tissue showed hepatoprotective properties against oxidative stress brought on by CCl4 after seven days of treatment with Hydromethanolic *Glycyrrhiza* root extract at doses of 300 to 600 mg/kg.[55] 18-β-glycyrrhetinic acid offers liver protection as it has also been shown to reduce P450E1 expression.[56] Aflatoxin-induced oxidative stress and liver damage are avoided by glycyrrhetinic acid.[57] At a dose of 2

Figure 1: Leaves, Flower, Root and Powder of *Glycyrrhiza Glabra*.

Figure 2: List of some key bioactive compounds found in licorice and their roles in alleviating various ailments.

mg/kg body weight, *Glycyrrhiza glabra* extracts are given once daily and significantly improve liver function in cases of acute liver disease.[58] *Glycyrrhiza aqueous* and methanolic extracts inhibit acute hepatotoxicity in rats caused by increased Aspartate aminotransferase activity.[59]

Neuroprotective Activity

Mice were used to study the effects of *Glycyrrhiza glabra* on memory and learning.[60] For seven days, mice were orally administered with different amounts of *Glycyrrhiza glabra* extract (75-300 mg/kg). Examined the results of applying an aqueous extract made from the roots of *Glycyrrhiza glabra*. On the memory and learning of male Wistar albino mice, aged one to one month, given dosages ranging from 75 to 300 mg/kg orally spread over six weeks. Although the precise mechanism underlying these improvements in learning and memory in mice is yet unknown, both trials showed a considerable increase in these areas.[61] These results point to licorice's potential neuroprotective benefit in the defense against illnesses like Alzheimer's disease. Chronic inflammation in specific brain regions is the root cause of Alzheimer's disease. Therefore, licorice's anti-inflammatory properties may be part of the benefits that have been shown to enhance memory.[62] Additionally, oxygen-free radicals are linked to aging and may be the cause of Alzheimer's disease in older adults. Licorice extract's preventive qualities can be linked to its antioxidant qualities, which lessen brain damage and enhance memory and neural function. Memory-enhancing effects may result from the combination of neuroprotective and anti-inflammatory properties.[63]

Table 2: Vernacular Names.[9]

Sanskrit	Madhuka, Yashti-madhu
Hindi	Mulaithi, Jothi-madh
English	Licorice, Sweet wood
Gujarati	Jethimadhu
Bengali	Jashtimadhu, Jaishbomodhu
Malayalam	Iratimadhuram
Tamil	Atimadhuram
Telugu	Atimadhuranu, Yashtimadhukam
Kannada	Yashtimadhuka, Atimaddhura

Antidiabetic Activity

An increasingly prevalent insulin-resistant condition in contemporary society is type 2 (non-insulin-dependent) diabetes mellitus. The expression of numerous genes necessary for the metabolism of fats and carbohydrates is controlled by ligand-dependent transcriptional regulators known as peroxisome proliferation-activated receptors, or PPARs. The three PPAR receptor types are PPAR-α, PPAR-γ, and PPAR-δ. Liver, kidney, and muscle contain PPAR-α. Adipose tissue, the adrenal glands, and the small intestine are linked to PPAR-γ, while PPAR-δ is expressed elsewhere. Insulin-sensitizing medications such as pioglitazone and rosiglitazone primarily target PPAR-γ. The significant PPAR-γ binding activity seen in the Licorice ethyl acetate extract was determined by the GAL-4-PPAR-γ chimeric assay to involve six phenolic chemicals: dehydroglyasperin, glycerine B, glycerine D, glycycoumarin, glycerine, glycerol, and acylglycerol. In mice, higher blood glucose levels following

sucrose loading in the oral sucrose tolerance test have been reported to be potentially lowered by glycerine and pioglitazone. Type-2 diabetes mellitus and insulin resistance were reduced by the powerful PPAR-γ agonist pioglitazone. Similarly, in knockout diabetic mice (KK-Ay), glycerin also demonstrated a strong PPAR-γ ligand binding activity, lowering blood glucose levels.[64]

Antimalarial Activity

Malaria is one of the worst diseases in Asia, Africa, and Latin America.[65] *Glycyrrhiza glabra* is one component that might help prevent malaria. The licorice root extract's 9.95 µg/mL water-methanol and 13 µg/mL ethyl acetate fractions demonstrated strong antiplasmodial activity against the *P. falciparum* strain with minimal toxicity to HeLa cells in*in vitro* studies. These fractions limit *P. berghei* development by 72.2% and 65% in mice, according to an *in vivo* investigation.[66] The compound licochalcone, found in licorice, has antimalarial properties. In mice, an oral dose of 1000 mg/kg has been shown to eradicate malarial parasites.[67]

Anti-tumour Activity

Both *in vivo* and *in vitro*, The aqueous extract of *Glycyrrhiza glabra* inhibits the growth of Ehrlich ascites tumor cells. Additionally, it suppresses the angiogenesis assays using peritoneal and chorioallantoic membranes.[68] In MCF-7 human breast cancer cells, ethanol extract from *Glycyrrhiza uralensis* roots also caused G1 cell cycle arrest and death.[69] However, several *in vitro* and *in vivo* studies have been conducted to determine the anti-cancer potential of various derivatives of its constituent constituents. By causing a change in mitochondrial permeability, glycyrrhetinic acid may also initiate the pro-apoptotic pathway. This characteristic may help cause tumor cells to undergo apoptosis.[70] When licochalcone E, a novel retrochalcone from *Glycyrrhiza* inflate roots, was compared to isoliquiritigenin and licochalcone A, two well-known anticancer drugs, it showed the strongest cytotoxic impact.[71]

Table 3: Pharmacological Activities of *Glycyrrhiza Glabra*.

Sl. No.	Plant Activity	Extract	Models of animals and cell lines
1.	Antiulcer	Acetone, Aqueous, Ethanolic extract of leaves	Helicobacter pylori was the microorganism used using the agar well diffusion method.[31]
2.	Anticancer	Extract of Licorice	Ames Test, reverence for Salmonella Typhimurium TA 98, Trp-P-1, and Trp-P-2.[32]
3.	Antioxidant	Extract of Methanol	It works against superoxide and nitric oxide molecules by utilizing the scavenging and reduction capabilities of the 1,1-Diphenyl-2-picrylhydrazyl radical.[33]
4.	Anti-inflammatory	Extract of Hydroalcoholic	Rat paw oedema was observed at dosages of 100, 200, and 300 mg/kg of carrageenan. The extract has a maximum 46.86% inhibitory activity.[34]
5.	Antimalarial	Extract of Alcoholic	Plasmodium falciparum was the microorganism used. Yoeli Plasmodium.[35]
6.	Antiviral	Extract of Aqueous	The vesicular stomatitis virus and herpes simplex 1.[36]
7.	Antitussive	Extract of Ethanol	Experimental animals coughed due to SO2 gas. *Glycyrrhiza glabra* extract therapy resulted in a 35.62% reduction in coughing in mice.[37]
8.	Antidyslipidaemic	Extract of Ethanol	The HFD-fed hamsters' LDL and VLDL were considerably lowered by fractions, but in different amounts.[38]
9.	Chronic Fatigue Syndrome	Extract of Hydroalcoholic	In mice, the extract showed a protective effect against chronic fatigue stress.[39]
10.	Hepatoprotective	Root Aqueous Extract	Rats' hepatocytes were damaged *in vivo* by PCM. Rabbit models. exposed to CCl4-induced acute liver damage.[40]
12.	Memory Enhancing	Root Aqueous Extract	Albino Wistar rats, three months old. Testing was done using the Morris Water Maze Test and the Elevated Plus Maze.[42]
13.	Testicular	Extract of Aqueous	Testicular toxicity in albino rats caused by carbendazim.[43]

Anti-tussive and Antidemulcent Activity

The licorice extract and powder worked well for treating bronchial catarrh, cough, and sore throat. According to studies, licorice is just as effective as codeine at relieving sore throats. It reduces inflammation and possesses expectorant qualities. The semi-synthetic substance carbenoxolone, which comes from the glycyrrhiza plant, increases the flow of mucus from the stomach. The licorice's calming properties are attributed to glycyrrhizin. Capsaicin-induced coughing is avoided by removing apioside, the active ingredient in methanolic licorice extract.[72]

Anticarcinogenic and Antimutagenic Activity

Glycyrrhiza glabra aqueous extract inhibits the growth of Ehrlich ascites tumor cells both *in vitro* and *in vivo*. It also inhibits the angiogenesis tests that use chorioallantoic and peritoneal membranes.[73] However, numerous *in vitro* and *vivo* investigations have offered thorough details on the anticancer properties of a number of derivatives made from its constituents. Glycyrrhetinic acid can trigger the proapoptotic cascade and lead to the death of tumor cells because it alters mitochondrial permeability.[74] Licorice acetone extract with a 70% methanol soluble fraction has been shown to increase Bcl2 phosphorylation and G2/M cycle arrest in tumor cell lines and cause cell death in human monoblastic leukemia U937 cells. The substance was determined to be Licocoumarone, which had antimicrobial and antioxidant qualities.[75] *Glycyrrhiza glabra* hydromethanolic root extract also demonstrated antimutagenic activity in albino mouse bone marrow cells by preventing the formation of micronuclei and chromosomal abnormalities.[76] The Activator Protein-1 (AP-1) activity was shown to be elevated by glycyrrhizin in untreated cells and decreased by TPA (12-O-tetradecanoylphorbal-13-acetate) in TPA-treated cells. Novel chemoprotective medications could be made using this approach as a model.[77]

Learning and memory-enhancing Activity

Because licorice contains antioxidants, it helps improve memory and neuron function while reducing the harmful effects of free radicals on the brain.[78] *Glycyrrhiza glabra* root extract was tested for its capacity to improve memory and learning using the Morris water maze and Plus-maze. An aqueous extract root dose of 150 mg/kg was sufficient to show a considerable improvement in memory and learning capacity.[79] The crude powdered root extracts were used to make *Glycyrrhiza glabra* tablets. Once it had been standardized, 123 male students participated in the experiment. A Non-Verbal Intelligence Test, or NVIT, was administered to each candidate after they had been divided into test and placebo groups. In comparison to a placebo, it was observed that taking licorice orally twice a day could raise students' IQ levels with few negative effects.[80]

Anti-thrombotic Effect

Glycyrrhiza glabra extract's *in vivo* effects as well as the combination effects of heparin and vitamin K were assessed in Sprague Dawley rats in a previously published study. Applying *Glycyrrhiza glabra* extract at 180 and 360 mg/kg was found to prolong the bleeding time. The hemoglobin concentration in the water solution allowed blood loss to be calculated as a function of absorbance at 540 nm. 60 min later. Based on the available data,*Glycyrrhiza glabra* appears to be a powerful anti-thrombotic drug.[81]

Anti-dyslipidaemia Effect

An earlier study examined the Antidyslipidemic effects of a 95% ethanolic root extract and its fractions in dyslipidaemic hamsters. The ethanolic extract, the ethyl acetate soluble fraction, and the water-soluble fraction extracted from *Glycyrrhiza glabra's* roots successfully reduced the levels of low-density cholesterol lipoprotein by 43.9%, 31.0%, 33.4%, and 24.6% respectively in hamsters fed a high-fat diet. In varying degrees, these fractions led to a decrease in the hamsters' levels of LDL and VLDL.[82]

Hair growth stimulating Activity

Good hair-growth-promoting properties were shown by the hydro-alcoholic licorice extract. A comparison of 2% concentration of licorice extract and the standard prescription (2% Minoxidil) showed that the licorice extract had a stronger stimulating effect on hair growth. Accordingly, studies on the efficacy and safety of licorice have demonstrated that it significantly promotes hair growth and that it is safe to use in herbal remedies for the treatment of different forms of alopecia.[83]

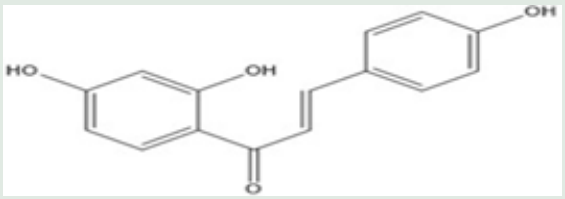
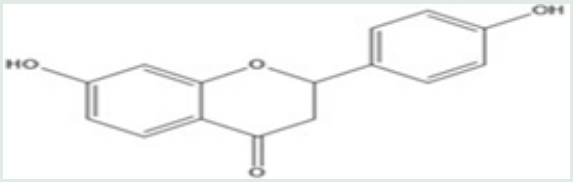
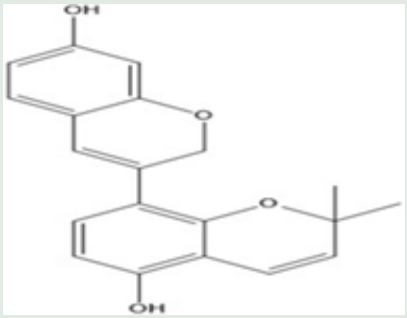
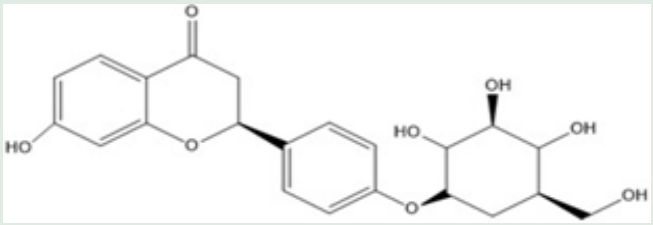
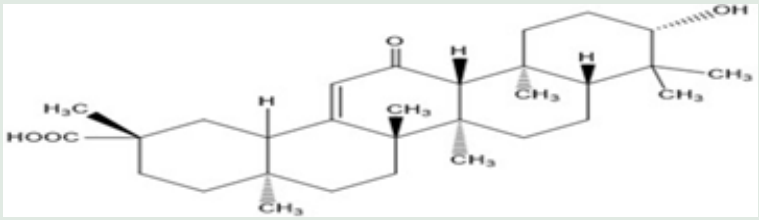
Skin-lightening Activity

One effective substance for lightening pigment is licorice extract. The hydrophobic licorice extract component glabridin inhibits tyrosinase activity in cultured B16 murine melanoma cells. Licochalcone A, Glabrene, and isoliquiritin are some of the other active ingredients in licorice extract that also inhibit tyrosinase activity. The dispersion of melanin caused by the liquidation of the licorice extract lightens the skin.[84]

CONCLUSION

This review looked at all the phytochemical compounds that were identified from *Glycyrrhiza glabra* as well as their therapeutic qualities. The primary ingredients that were separated from *Glycyrrhiza glabra* extracts include glycyrrhizic acid, glycyrrhizin, and licochalcones. *Glycyrrhiza glabra* and its main constituents have pharmacological qualities that include antimicrobial, antiviral, antitussive, immune-stimulating, antioxidant, and anti-inflammatory effects. Due to the increased adverse effects of allopathic medications, there has been a global surge in demand for phytopharmaceuticals. This provides a solid foundation to

Chemical Structures

Isoliquiritigenin	
Liquiritigenin	
Glabrene	
Liquiritin	
Glycyrrhizin	

choose plants for additional pharmacological and phytochemical studies. Based on the clinical and pharmacological studies that this review Includes, *Glycyrrhiza glabra* is proven to have medicinal benefits. The existence of chemical components suggests that in the years to come, the plant may be used as a "lead" for the development of new treatments for diseases. To investigate *Glycyrrhiza glabra* Linn's potential for illness prevention and treatment, more research is required in this area. To obtain significant medical medications, the current evaluation guides future researchers studying the plant.

FUNDING

The author(s) reported that there is no funding associated with the work featured in this article.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

ABBREVIATIONS

HIV: Human Deficiency Virus; **HPLC:** High Performance Liquid Chromatography; **UK:** United Kingdom; **USA:** United States of America; **Trp:** Tryptophan Pyrolysis Product; **HFD:** High Fat Diet; **LDL:** Low-Density Lipoprotein; **VLDL:** Very Low-Density Lipoprotein; **PCM:** Paracetamol; **CCl4:** Carbon tetrachloride; **DPPH:** 2,2- Diphenyl-1-picrylhyrazyl; **MCF:** Michigan Cancer Foundation.

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Cite this article: Shakya A, Kumar K. Critical Review on Phytoconstituents and Pharmacological Activity of *Glycyrrhiza Glabra*. Pharmacog Res. 2025;17(4):x-x.