ISSN: 2322 - 0902 (P)
ISSN: 2322 - 0910 (O)

International Journal of Ayurveda and Pharma Research

Review Article

THERAPEUTIC EFFECTS OF *GLYCYRRHIZA GLABRA* LINN

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Article info

Article History:
Received: 12-10-2023
Accepted: 18-11-2023
Published: 10-12-2023

KEYWORDS:
Glycyrrhiza glabra Linn, Liquorice, *Yashtimadhu, Medhya, Ayurveda.*

ABSTRACT

Glycyrrhiza glabra Linn. (Licorice, *Yashtimadhu* in Sanskrit; Family: Fabaceae) is a popular Indian medicinal plant mentioned as a *Medhya Rasayana* in Ayurvedic literatures and Nighantus. The important chemical constituent of *Yashtimadhu* is glycyrrhizin (about 2-9%), Glycyrrhetinic acid (glycyrrhetic) (0.5-0.9%). Isoflavonoids, chalcones, triterpenoids, coumarins, sterols, amino acids, amines, lignans, gums and volatile oils are other active constituents. These are found to be responsible for its various activities like antiulcer activity, wound healing activity, eye problems, cognitive function enhancing activity, anti-inflammatory, antioxidant activity, anti-tussive activity etc. Recent researches have also shown its positive effect as a memory enhancer, neuroprotectant, and attenuating neuroinflammation. In Ayurveda, *Medhya rasayana* comprises a major category of nootropic herbs that are indicated for all mental disorders. *Yashtimadhu* is one of *Medhya* drugs mentioned to enhance mental abilities, concentration, cognitive function and intelligence. The objective of this paper is to review the literature regarding its traditional uses, its impact on the *Doshas*, and the scientific evidence supporting its therapeutic properties.

INTRODUCTION

In the realm of Ayurveda, the ancient system of holistic healing, nature has bestowed upon us a multitude of precious herbs with exceptional medicinal properties. One such revered herb is *Glycyrrhiza glabra*, known as *"Yashtimadhu"* in Ayurveda. This herb, with its rich history and diverse applications, has been treasured for centuries as a potent remedy for various health concerns.

Glycyrrhiza glabra, commonly referred to as licorice, is a perennial plant native to the Mediterranean and certain parts of Asia. The root of *Glycyrrhiza glabra* is the part predominantly utilized in Ayurvedic preparations, harnessing its potent medicinal potential. The traditional uses of *Yashtimadhu* include several medicinal properties, such as gastro-protective[1], hepatoprotective[2], nephroprotective[3], expectorant [4], antiviral [5], immunomodulatory[6], and anti-angiogenic and antitumor properties[7]. Among its various therapeutic properties, *Yashtimadhu* is better known for its efficacy as a neuroprotectant, memory enhancer and attenuating neuroinflammation.[8,9]

In Ayurveda the *Medya Rasayana* is mentioned to enhance mental abilities, concentration, cognitive function and intelligence. It is one of the *Medhya rasayana* which comprises a major category of nootropic herbs that are indicated for all mental disorders. *Medhya rasayana* drugs enhance the function of *Buddhi* (intellect), decreases the *Rajas* and *Tamas Doshas* and improves the functions of *Manas*. In *Charaka Samhita, Yashtimadhu* is described as *"Kṣhireṇa yaṣṭimadhukasya churṇam. Medhyani caitani rasayanani"*[10] meaning when its powdered form is taken with milk it functions as *Medhya* as well as *Rasayana.* Some other herbs indicated for their *Medhya* action are *Manḍukaparṇi* (*Centella asciatica* Linn.), *Guḍuci* (*Tinospora cordifolia* Wild. Miers) and *Sankhapuṣpi* (*Convolvulus pluricaulis* Choisy.); in distinct dosage forms.[11]

In this article, we will delve deeper into the insights surrounding *Glycyrrhiza glabra*, exploring its traditional uses, its impact on the *Doshas*, and the scientific evidence supporting its therapeutic properties.

Review of different Ayurveda literatures as a primary source of data along with the literature review as secondary data from reputed journal papers and

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https://doi.org/10.47070/ijapr.v11i11.2910

other e-resources documenting the pharmacological properties of *Yashtimadhu* (*Glycirrhiza glabra* Linn.) was done.

Yashtimadhu [12]

Description

Common Name: *Yashtimadhu*

English Name: Liquorice, Licorice

Botanical name: *Glycyrrhiza glabra*

Family: Fabaceae

Parts used: Root

Morphology

Habit: Tall perennial plant

Stem: Erect

Leaves: Compound, elliptic lanceolate

Inflorescence: Raceme

Flowers: Bluish or violet color

Fruit: Pod, oblong to linear

Parts used: Roots and stolen

Chemical Constituents[13]

Licorice root contains compounds such, as triterpene saponins, flavonoids, polysaccharides, pectins, simple sugars, amino acids and mineral salts. The sweet taste of licorice is attributed to a compound called Glycyrrhizin. This compound is a mixture of potassium calcium magnesium salts of glycyrrhizic acid. The presence of flavonoids in the plant gives licorice its color. Includes liquiritin and isoliquiritin (a chalcone) along, with other compounds. Some specific compounds found in licorice like glabridin and hispaglabridins A and B have antioxidant activity. Additionally, both Glabrene exhibit estrogen like properties.

Ayurvedic Pharmacological Action

Table 1: Ayurveda Pharmacological Properties [14]

Rasa	***Guna***	***Veerya***	***Vipaka***	***Prabhava***	***Dosha Karma* and *Dhatu karma***
Madhura	*Guru, Snigdha*	*Sita*	*Madhura*	*Medhya*	*Vatapitta-shamaka, Rasayana*

Glycyrrhiza glabra Linn. (Licorice, *Yashtimadhu* in Sanskrit; Family: Fabaceae) is a popular Indian medicinal plant mentioned as a *Medhya.* It has *Madhura* (sweet) *rasa*, *Guru* (heavy) and *Snigdha* (unctuous) *Guna, Sita* (cold) *virya*, with *Madhura Vipaka. Vatapittashamaka* (alleviates *Vata* and *Pitta*). The *Prabhava* of *Yashtimadhu* is *Medhya. Balya* (tonic), *Keshya* (good for hairs), *Varnya* (good for complexion), *Swarya* (good for voice), *Asra doshahara* (alleviates blood disorders) and *Shukrala* (aphrodisiac). Indicated in *Vranasotha* (inflammatory swelling), *Visha* (poisonous conditions), *Chardi* (vomiting), *Trishna* (excessive thirst) and *Glani* (lassitude). The dried root powder is often consumed with milk, for its benefits as a *Medhya.*

Therapeutic Properties

- Powder of *Yastimadhu* mixed with milk should be given daily as *Medhya Rasayana*.[15]
- For management of epilepsy, the root of *Yastimadhu* is cooked in ghee with fruit juice *Dhatri* given to epileptic patient.[16]
- The powder of *Yastimadhu* is used as *Nasya* in *Ardhavbhedaka*.[17]
- *Yastimadhu* mixed with *Sunthi* is given orally for the treatment of *Kshataksheena* [18]
- *Yastimadhu* mixed with *Kutaki* and sugar is given for treatment of *Pittaja Hridroga*.[19]
- For the treatment of *Garbhashuska* (IUGR) milk medicated with *Yastimadhu churna* and decoction of *Gambari* is given to the pregnant women daily.[20]
- *Yastimadhu* and *Gambhari kalka* is used in *Taila paka* in *Vatarakta*.[21]
- The root is used as a decoction to treat *Pandu roga* with honey.[22]
- *Bhagandara*: the wound should be applied with *Madhu Taila* [23]
- *Bhavmishra* recorded analgesic activities of *Yastimadhu* on administration in the form of *Nasyakarma* to relieve all types of headaches. He also describes that *Yastimadhu* relives cough immediately.[24]
- *Vangasen* has reported antiepileptic activity in combination with *Kushmanda Swarasa*. [25]
- *Chakradutta* suggested its application on ulcers due to injury for relieving pain (analgesic).[26]

Pharmacological Actions

Table 2: Neuroprotective Effect

Researcher/ Author	Methodology	Outcome
Ya-Jen Chiu et.al 2021 [27]	The neuroprotective effect of formulated CHM Shaoyao Gancao Tang (SG-Tang, made of *Paeonia lactiflora* and *Glycyrrhiza uralensis* at 1:1 ratio) in Alzheimer's disease (AD) cell and mouse models.	SG Tang has the potential to act as a measure, against the aggregation of Aβ and neuroinflammation by reducing the activity of the NLRP1/NLRP3 pathways. These findings further support the idea that neuroinflammation mediated by microglia plays a role, in the development of Alzheimers disease, which can influence treatment approaches targeting inflammasomes.
Chiyeon Lim et.al. 2018 [28]	The methanol extract of licorice was administered in mice subjected to middle cerebral artery occlusion (MCAO)	The neuro-protective effect of licorice was revealed. These findings indicate that licorice may have the potential to be an option, for treating brain damage caused by ischemia.
Lidan Luo et. al, 2014 [29]	Kainic acid induced animal seizure experiment in which systemic administration of *Glycyrrhiza glabra* was given.	It significantly suppressed neuronal cell death and drastically decreased gliosis and proinflammatory marker inductions. Results indicate that the neuroprotective effect of GL
Bojiang Shen et.al 2013 [30]	The antioxidant capacity of the herbal extracts was determined using three non-cellular assays and Cytotoxic effects of the herbal extracts were assayed in cultured mouse cortical neurons and their neuroprotective activities were studied using staurosporine-induced apoptosis of the cultured neurons.	Extracts of *Ganoderma lucidum*, *Glycyrrhiza glabra*, *Schizandra chinensis*, and *Polygonum cuspidatum* shows various levels of reactive oxygen species (ROS) scavenging capacity, which was significantly correlated with their neuro- protective activity.
Seung-Woo Kim et.al 2012 [31]	The administration of Glycyrrhizin (GL) (10mg/kg) intravenously at 3 or 6h in the postischemic rat brain after middle cerebral artery occlusion (MCAO)	GL has been found to have effects, on the brain after events. It achieves this through its ability to reduce inflammation prevent excitation of brain cells and counteract oxidative stress. One of its mechanisms involves inhibiting the release of HMGB1, which contributes to its inflammatory properties.
P. Muralidharan et.al 2009 [32]	The aqueous extract of *Glycyrrhiza glabra* Linn. Roots (at doses of 250 and 500 mg/kg) was investigated for its potential to protect the brain in rats exposed to hypoxia. To induce hypoxia rats were given drinking water containing sodium, for duration of 14 days.	The aqueous extract improves anti-hypoxic effects induced by sodium nitrite and this effect may be mediated by its antioxidant as well as neuro-protective properties.
Xue-Qing Yu et.al 2008 [33]	Glabridin at 25mg/kg by intraperitoneal injection in cerebral injuries induced by middle cerebral artery occlusion (MCAO) in rats and staurosporine-induced damage in cultured rat cortical neurons and the possible mechanisms involved.	Study showed that glabridin significantly decreased the focal infarct volume, cerebral histological damage and apoptosis in MCAO rats compared to sham-operated rats.

Table 3: Effect on Learning and Memory

Researcher/Author	Methodology	Outcome
Hongyan Pei et.al 2023 [34]	In the experiment researchers examined the effects of injecting lipopolysaccharide (LPS) into mice to induce damage, in their brains. They also assessed the mices learning and memory abilities as their anxiety levels using water maze and open field tests.	The flavonoids found in the stem and leaves of Glycyrrhiza glabra had an impact, on oxidative indicators such, as superoxide dismutase (SOD) catalase (CAT) malonaldehyde (MDA) acetylcholine (Ach) acetylcholinesterase (AchE) Caspase 3, Caspase 9 and serum inflammatory factors TNF α, IL 6 and IL 1β.
Matteo M Pusceddu et. al 2022 [35]	Study on influence of Mediterranean natural extracts (MNE), Rosemary extract (RE) and *Glycyrrhiza glabra* root extract (GGRE), on cognitive behavior on adult zebrafish and rats.	MNE improved cognition in both zebrafish and rats.
Yong-Hyun Ko et. al 2017 [36]	The cognitive enhancing effects of Liquiritigenin (LQ), a flavonoid extracted from the radix of *Glycyrrhiza*, on learning and memory impairments induced by scopolamine (0.5 mg/kg, i.p.), a muscarinic antagonist, using the Y-maze, passive avoidance, and novel object recognition tests.	The findings suggest that LQ could potentially be beneficial, in addressing issues, with learning and memory and that its positive effects are partially attributed to the enhancement or protection of cholinergic signaling.
Jie Guo et.al, 2016 [37]	Neuroprotective effects of glycyrrhizic acid (GA) in a Vascular Dementia (VD) rat model induced by permanent occlusion of the bilateral common carotid arteries.	Neuroprotective effects of GA in VD rats relate to the reduction of oxidative stress and inhibition of VGSCs. The study provides experimental evidence for the application of GA in the treatment of cognitive deficits induced by Alzheimer's disease, stroke, or traumatic brain injury.
Kosuri Kalyan Chakravarthi et.al, 2014 [38]	The study examined the impact of an extract derived from the root of Gg on the structure of hippocampal Cornu Ammonis area three (CA3) neurons, in male Wistar albino rats that were one month old.	The results indicated that administering the root extract of Gg at doses of 150 and 225 mg/kg/p.o enhanced dendritic arborization (the branching points) and dendritic intersections along both apical and basal dendrites in hippocampal (CA3) pyramidal neurons. These effects were comparable, to the control group.
Kosuri Kalyan Chakravarthi et.al., 2013 [39]	The aqueous extracts were evaluated for their effect on spatial learning and memory in rats using the elevated plus maze, Hebb-William maze, and Morris's water maze tests which served as the exteroceptive behavioral model.	Results showed improvement in the management of impaired learning, dementia, Alzheimer's disease, and other neurodegenerative disorders.
Michel, Haidy E et al. 2013 [40]	Prepulse inhibition (PPI) response due liquorice/its constituents augmented mouse brain monoamine levels.	Results demonstrated that the extract anti-amnestic dose augmented cortical, hippocampal and striatal monoamine levels.
Parisa Hasanein et.al, 2011 [41]	The effect of chronic treatment with glabridin on cognitive function in control and streptozotocin (STZ)-induced diabetic rats	The result shows that glabridin prevented the deleterious effects of diabetes on learning and memory in rats.
Yong-Ming Cui et.al, 2008 [42]	The researchers examined the impact of Glabridin, which is derived from the roots of Glycyrrhiza glabra on functions	The findings suggest that Glabridin shows promise in enhancing memory and it could be valuable to investigate its benefits for

	and cholinesterase activity, in mice.	managing patients, with Alzheimers disease.
Mohammad Sharifzadeh et.al, 2008 [43]	The effects of administering an extract, from *G. Glabra* L. to rats, on their ability to retain memory in the Morris water maze.	The results showed that the enhancement effect of GE on spatial memory retention does not correlate with GA blood levels.
Dinesh Dhingra et.al, 2006 [44]	A study was conducted to assess the effects, on acetylcholinesterase of extracts, from Glycyrrhiza glabra Myristica fragrans seeds and ascorbic acid.	The obtained values were then compared to those of an acetylcholinesterase inhibiting drug called metrifonate. The levels of acetylcholinesterase enzyme were measured in mice brains.
Milind Parle et.al, 2004 [45]	The aqueous extract of G. *glabra* were administered for 7 successive days in mice.	G. *glabra* has shown as a memory enhancer in both exteroceptive and interoceptive behavioural models of memory. Anti-inflammatory and antioxidant properties contributed in the memory enhancement effect.
Dinesh Dhingra et.al, 2004 [46]	*Glycyrrhiza glabra* on learning and memory in mice	The effect of *Glycyrrhiza glabra* on learning and memory was due to facilitation of cholinergic-transmission in mouse brain and scopolamine-induced amnesia was reversed by liquorice.

Table 4: Anti-Depressant-Like Activity

Researcher/Author	Methodology	Outcome
Harald Murck et.al, 2020 [47]	*Glycyrrhiza glabra* (GG) extract containing 7-8% of glycyrrhizin was administered at a dose of 2×700mg daily adjunct to standard antidepressants in hospitalized patients with major depression.	Glycyrrhizin possess a beneficial effect on antidepressant response.
Suengmok Cho et.al, 2012 [48]	*Glycyrrhiza glabra* ethanol extract (GGE) administered in mice.	The results imply that GGE and its flavonoid glabrol induce sleep via a positive allosteric modulation of GABA(A)-BZD receptors.
Weixing Wang et.al, 2008 [49]	Antidepressant activity of liquiritin and isoliquiritin from *Glycyrrhiza* in mice.	Liquiritin and isoliquiritin produced significant anti-depressant-like effects, and their mechanism of action in the mouse hippocampus, hypothalamus and cortex was found.
Dinesh Dhingra et.al, 2006 [50]	The researchers gave Swiss young male albino mice doses of *G. Glabra* extract (75, 150 and 300mg/kg) for seven consecutive days.	It appears that the liquorice extract has an antidepressant effect, by increasing levels of norepinephrine and dopamine in the brain than, by affecting serotonin levels. The liquorice extract's ability to inhibit monoamine oxidase may also contribute positively to its antidepressant activity.

Table 5: Antioxidant Activity

Researcher/Author	Methodology	Outcome
Jurga Andreja Kazlauskaite et.al, 2023 [51]	Biological activity of *Glycyrrhiza glabra* L., *Trifolium pratense* L. Extracts and *Myristica fragrans* Houtt. Was studied.	Liquorice extract is found to have antibacterial activity against Gram-positive pathogens and the highest antioxidant activity.
Paiheerding Mutaillifu et.al, 2020	A water-soluble polysaccharide, named GPN, with molecular mass 38.7 KDa	G.*glabra* polysaccharide showed good antioxidant activity.

[52]	was isolated from *Glycyrrhiza glabra*	
Luca Frattaruolo et.al, 2019 [53]	The study examined the makeup of three extracts from *Glycyrrhiza glabra* L. (licorice) leaves. These extracts were obtained using either maceration or an ultrasound assisted method and both fresh and dried leaves were used in the process.	All the extracts possessed similar antioxidant properties.
Alessandro Dal Bosco et.al, 2019 [54]	The effect of liquorice extract (in feed and/or directly in burgers) on the shelf-life of rabbit meat was studied.	Showed a significant positive effect of dietary liquorice and a progressive increase in antioxidant effectiveness.
Eby Aluckal et.al, 2017 [55]	Antimicrobial activity and total antioxidant capacity (TAC) of licorice in Saliva of HIV/AIDS patients.	G. *glabra* extracts showed good anticandidal activity and also high antioxidant property which reduces the oxidative stress of HIV-infected people.
Iram Iqbal Hejazi et.al, 2017 [56]	The antioxidant and apoptotic properties of *Glycyrrhiza glabra* L. in both cell free and cell culture system was investigated.	The levels of antioxidant enzymes SOD, CAT, GST, GPx and GR, in the tissues that experienced stress showed an improvement following treatment, with the methanol fraction derived from the plant.
Guojun Yin et.al, 2011 [57]	Hepatoprotective and antioxidant effects of *Glycyrrhiza glabra* extract (2.5, 5 and 10 µg/ml) on the carbon tetrachloride (CCl(4))-induced carp hepatocyte damage in vitro.	The results shows that the *Glycyrrhiza glabra* extract as a hepatoprotective and antioxidant agent in fish.
Nishant P Visavadiya et.al, 2006 [58]	*Glycyrrhiza glabra* (GG) root powder were examined in hypercholesterolaemic male albino rats for its antioxidant activity.	The antioxidant status was improved upon treatment.

Table 6: Anti-Ulcer Property

Researcher/Author	Methodology	Outcome
Chunying Huang et.al., 2022 [59]	*Glycyrrhiza* polysaccharide (GPS) effect on induced acute ulcerative colitis (UC) mice	High therapeutic efficacy and a good safety profile, for enteritis and beyond.
Yi Yang, et.al., 2017 [60]	The anti-ulcer effect of licoflavone, aiming at elucidating the possible molecule mechanisms of its action for treating gastric ulcer rats induced by acetic acid.	Licoflavone plays the role of treating gastric ulcer by regulating inflammation mediators and amino acid metabolism.
Moumita Mukherjee et.al., 2010 [61]	GutGard, a standardized extract of *Glycyrrhiza glabra* was studied.	GutGard has shown potential in preventing ulcers through its ability to protect the stomach lining due, to its anti-ulcer properties.
Adel M Aly et.al., 2005 [62]	Anti-inflammatory and anti-ulcer activity of *Glycyrrhiza glabra* was conducted in male albino rats.	anti-inflammatory activity and anti- ulcer activity was concluded.
M T Khayyal et.al., 2001 [63]	Anti-ulcerogenic activity against indometacin induced gastric ulcers of the rat as well as for their antisecretory and cytoprotective activities was studied.	The anti-ulcerogenic activity of the extracts was confirmed.

Table 7: Anti-Convulsant Activity

Researcher/ Author	Methodology	Outcome
Bimalendu Chowdhury et.al., 2013 [64]	Aqueous and ethanol extract of *Glycyrrhiza glabra* was tested for its anti-convulsant activity using pentylenetetrazole (PTZ)-induced seizure in rat.	Poses anti-convulsant potential in PTZ-induced seizure.

Table 8: System Wise Action

System	Action
Respiratory system	For dissolving and facilitating the discharge of mucus in catarrhs and for upper respiratory tract. [65]
Gastrointestinal system	Gastric and duodenal ulcer [66]; adjuvant in treating spasmodic pains of chronic gastritis,[67] laxative [68]
Cardiovascular system	Antioxidant, hypolipidemic [69,70]
Genital–urinary system	No described rational uses, but a diuretic effect only in association with other herbals [71]
Nervous system	Neuroprotective, learning and memory, cognitive, cerebroprotective [72]
Skin	For the treatment of atopic dermatitis[73], anti-inflammatory against U.V., oedema and erythema [74]

DISCUSSION

Medhya rasayana comprises a major category of nootropic herbs that are indicated for all mental disorders. *Yashtimadhu*, being one of the potent Medhya drugs of which fine powder of dried root is used internally with milk for therapeutic purpose as Medhya. The study by Zhu Z et. al., 2006, Hongyan Pei et. al, 2023[75] reveals the therapeutic action of *Glycyrrhiza glabra* on learning and working memory. Similarly, the Table: 02 depict the studies which prove the effect of *Yashtimadhu* on learning and memory. Besides this, Table: 01 clearly provokes the neuroprotective effect of G. *glabra*. *Glycyrrhiza glabra* appears to be a promising drug for improving memory in the management of impaired learning, dementia, Alzheimer's disease, and other neurodegenerative disorders.[76] Also, the study by Kim SW et. al., 2012[77] shows improvements in motor dysfunction and neurological disorders and inhibition of microglia activation and proinflammatory cytokine production followed by neuroprotective impact. Another study reveals anti-stress and resistance to stress is enhanced due to active substances of licorice root. [78] Table: 03 i.e., studies of *Glycyrrhiza glabra* as anti-depressant-like activity as it supports due to increase of brain norepinephrine and dopamine, but not by increase in the level of serotonin. The potential antidepressant like activity of liquorice may be attributed to its ability to inhibit monoamine oxidase.[79] The antioxidant property of *Glycyrrhiza* is supported by the studies in the Table: 04 as the antioxidants play a role, in safeguarding brain cells against the harmful effects of oxidative stress. This in turn leads to a decrease, in brain damage. Promotes functioning of neurons ultimately enhancing memory.[80] The anti-ulcer property is confirmed by the studies mentioned in Table: 05. The cytoprotective effect could be partly due to their flavonoid content and to their free radical scavenging properties.[81] Results of various research studies and clinical trials strongly supports the different therapeutic activities of *Glycyrrhiza glabra* as cognitive function enhancing activity, anti-inflammatory, antioxidant activity, anti-tussive activity, antiulcer activity, wound healing activity and its positive effect as a memory enhancer, neuroprotectant, and attenuating neuroinflammation. Thus, *Glycyrrhiza glabra* and their extracts can be used for the treatment of different diseases and health maintenance.

CONCLUSION

Research studies have clearly demonstrated that the various constituents of *Glycyrrhiza glabra* exhibit a variety of therapeutic effects. The results are very encouraging and indicate this herb in multiple systemic disorders. Clinical studies should be conducted more extensively to confirm these results and reveal other potential therapeutic effects.

REFERENCES

1. Nugroho, Agung Endro et al. "Gastroprotective Effect of Combination of Hot Water Extracts of Licorice (Glycyrrhiza glabra), Pulasari Stem Bark (Alyxia reinwardtii), and Sembung Leaf (Blumea balsamifera) Against Aspirin-Induced Gastric Ulcer Model Rats." Journal of evidence-based complementary & alternative medicine vol. 21, 4 (2016):NP77-84.doi:10.1177/2156587216637469
2. Huo, Hai Zhong et al. "Hepatoprotective and antioxidant effects of licorice extract against CCl_4-induced oxidative damage in rats." International

journal of molecular sciences vol. 12, 10 (2011): 6529-43. doi:10.3390/ijms12106529

3. Mohamed, Naglaa El-Shahat. "Effect of Aqueous Extract of Glycyrrhiza glabra on the Biochemical Changes Induced by Cadmium Chloride in Rats." Biological trace element research vol. 190, 1 (2019): 87-94. doi:10.1007/s12011-018-1525-5
4. Kuang, Yi et al. "Antitussive and expectorant activities of licorice and its major compounds." Bioorganic & medicinal chemistry vol. 26, 1 (2018): 278-284. doi:10.1016/ j.bmc.2017.11.046
5. Feng Yeh, Chia et al. "Water extract of licorice had anti-viral activity against human respiratory syncytial virus in human respiratory tract cell lines." Journal of ethnopharmacology vol. 148, 2 (2013): 466-73. doi:10.1016/j.jep.2013.04.040
6. El-Saber Batiha, Gaber et al. "Traditional Uses, Bioactive Chemical Constituents, and Pharmacological and Toxicological Activities of Glycyrrhiza glabra L. (Fabaceae)." Biomolecules vol. 10, 3 352. 25 Feb. 2020, doi:10.3390/biom 10030352
7. Sheela, M L et al. "Angiogenic and proliferative effects of the cytokine VEGF in Ehrlich ascites tumor cells is inhibited by Glycyrrhiza glabra." International immunopharmacology vol. 6, 3 (2006): 494-8. doi:10.1016/j.intimp.2005.07.002
8. Sarokte, Atul Shankar, and Mangalagowri V Rao. "Effects of Medhya Rasayana and Yogic practices in improvement of short-term memory among school-going children." Ayu vol. 34, 4 (2013): 383-9. doi:10.4103/0974-8520.127720
9. Sheshagiri, Srihari et al. "Randomized placebo-controlled clinical study on enhancement of Medha (intelligence quotient) in school going children with Yahstimadhu granules." Ayu vol. 36, 1 (2015): 56-62. doi:10.4103/0974-8520.169011
10. Kashinath Shastry and Dr.G.N Chaturvedi; Charak Samhita of Agnivesh revised by CharaK and Dridbala with the Vidyotini Hindi Commentary Part II Chkitsa Sthan Chapter C.S. Chi 1/31
11. Paradakara HS. 4th ed. Varanasi: Chaukhambha Sanskrita Sansthana; 2010. Astanga Hridaya: Sanskrit commentary.
12. Kashinath Shastry and Dr.G.N Chaturvedi; Charak Samhita of Agnivesh revised by CharaK and Dridbala with the Vidyotini Hindi Commentary Part II Chkitsa Sthan Chapter C.S. Chi 1/30
13. Database of Medicinal plants, Volume-3, pg no-618
14. The Ayurvedic Pharmacopoeia of India Part- I Volume – I, Page. no: 79
15. Kashinath Shastry and Dr.G.N Chaturvedi; Charak Samhita of Agnivesh revised by CharaK and Dridbala with the Vidyotini Hindi Commentary Part II Chikitsa Sthan Chapter C.S. Chi 1/30, P.no.-39
16. Kashinath Shastry and Dr.G.N Chaturvedi; Charak Samhita of Agnivesh revised by CharaK and Dridbala with the Vidyotini Hindi Commentary Part II Chikitsa Sthan Chapter C.S. Chi 10/31, Page no.-333
17. Sushruta Samhita of Sushruta ,Edited with Ayurveda Tatva Sandeepika Hindi commentary by Kaviraj Ambikadutt Shastri Part II Uttar Tantra Chapter 26, Verse-33 Published by Chaukambha Sanskrit Sansthan , Varanasi , Edition Reprint 2013 Page No. 179
18. Kashinath Shastry and Dr.G.N Chaturvedi; Charak Samhita of Agnivesh revised by Charak and Dridbala with the Vidyotini Hindi Commentary Part II Chikitsa Sthan Chapter C.S. Chi 11/20, Page no.-343
19. Kashinath Shastry and Dr.G.N Chaturvedi; Charak Samhita of Agnivesh revised by CharaK and Dridbala with the Vidyotini Hindi Commentary Part II Chikitsa Sthan Chapter C.S. Chi 26/91-92, Page no.-734
20. Kashinath Shastry and Dr. G.N Chaturvedi; Charak Samhita of Agnivesh revised by CharaK and Dridbala with the Vidyotini Hindi Commentary Part II Chikitsa Sthan Chapter C.S. Chi 28/95, Page no.-794
21. Kashinath Shastry and Dr.G.N Chaturvedi; Charak Samhita of Agnivesh revised by Charak and Dridbala with the Vidyotini Hindi Commentary Part II Chikitsa Sthan Chapter C.S. Chi 29/116, Page no.-833
22. Sushruta Samhita of Sushruta ,Edited with Ayurveda Tatva Sandeepika Hindi commentary by Kaviraj Ambikadutt Shastri Part II Uttar Tantra Chapter 44, Verse-23 Published by Chaukambha Sanskrit Sansthan, Varanasi, Edition Reprint 2013 Page No. 373
23. (Shu. Chi. 8) Sushruta Samhita of Sushruta ,Edited with Ayurveda Tatva Sandeepika Hindi commentary by Kaviraj Ambikadutt Shastri Part I Chikitsa Sthan Chapter 8, Verse-44 46 Published by Chaukambha Sanskrit Sansthan, Varanasi, Edition Reprint 2014 Page No. 61
24. (Shu. Chi. 8) Sushruta Samhita of Sushruta ,Edited with Ayurveda Tatva Sandeepika Hindi commentary by Kaviraj Ambikadutt Shastri Part I Chikitsa Sthan Chapter 8, Verse-44 46 Published by Chaukambha Sanskrit Sansthan, Varanasi, Edition Reprint 2014 Page No. 61
25. Vangasena, by Bopadeva, commented by Shaligram, Mumbai; Khemraj Shrikrishnadas Prakashan, 1996.

26. Chakrapani Datta. Chakradatta of Shri Chakrapani Datta with the Padarthabodhini Hindi Commentary bt Vd. Ravidatta Shastri Reprint Varanasi; Chaukhambha Surbharti Prakashan; 2006: 160
27. Chiu, Ya-Jen et al. "Formulated Chinese medicine Shaoyao Gancao Tang reduces NLRP1 and NLRP3 in Alzheimer's disease cell and mouse models for neuroprotection and cognitive improvement." Aging vol. 13, 11 (2021): 15620-15637. doi:10.18632/aging.203125
28. Lim, Chiyeon et al. "Licorice Pretreatment Protects Against Brain Damage Induced by Middle Cerebral Artery Occlusion in Mice." Journal of medicinal food vol. 21, 5 (2018): 474-480. doi:10.1089/jmf.2017.4044
29. Luo L, Jin Y, Kim ID, Lee JK (2014) Glycyrrhizin suppresses HMGB1 inductions in the hippocampus and subsequent accumulation in serum of a kainic acid-induced seizure mouse model. Cell Mol Neurobiol 34: 987-997.
30. Shen, Bojiang et al. "An in vitro study of neuroprotective properties of traditional Chinese herbal medicines thought to promote healthy ageing and longevity." BMC complementary and alternative medicine vol. 13 373. 27 Dec. 2013, doi:10.1186/1472-6882-13-373
31. Kim SW, Jin Y, Shin JH, Kim ID, Lee HK, et al. (2012) Glycyrrhizic acid affords robust neuroprotection in the postischemic brain via anti-inflammatory effect by inhibiting HMGB1 phosphorylation and secretion. Neurobiol Dis 46: 147-156.
32. Muralidharan P. Cerebroprotective effect of Glycirrhyza glabra Linn root extract on hypoxic rat. J Bangladesh Pharmacol Soc 2009; 4: 604.
33. Yu XQ, Xue CC, Zhou ZW, Li CG, Du YM, et al. (2008) In vitro and in vivo neuroprotective effect and mechanisms of glabridin, a major active isoflavan from Glycyrrhiza glabra (licorice). Life Sci 82: 68-78.
34. Pei, Hongyan et al. "PI3K-Akt signaling pathway based on network pharmacology for the anti-Alzheimer's disease effect of licorice stem flavonoids." Aging vol. 15, 9 (2023): 3381-3393. doi:10.18632/aging.204536
35. Pusceddu, Matteo M et al. "Mediterranean natural extracts improved cognitive behavior in zebrafish and healthy rats and ameliorated lps-induced cognitive impairment in a sex dependent manner." Behavioral and brain functions: BBF vol. 18, 15. 25 Feb. 2022, doi:10.1186/s12993-022-00190-8
36. Ko, Yong-Hyun et al. "Liquiritigenin ameliorates memory and cognitive impairment through cholinergic and BDNF pathways in the mouse hippocampus." Archives of pharmacal research vol. 40, 10 (2017): 1209-1217. doi:10.1007/s12272-017-0954-6
37. Guo, Jie et al. "Glycyrrhizic Acid Ameliorates Cognitive Impairment in a Rat Model of Vascular Dementia Associated with Oxidative Damage and Inhibition of Voltage-Gated Sodium Channels." CNS & neurological disorders drug targets vol. 15, 8 (2016): 1001-1008. doi:10.2174/1871527315666160527163526
38. Chakravarthi, Kosuri Kalyan, and Ramakrishna Avadhani. "Enhancement of Hippocampal CA3 Neuronal Dendritic Arborization by Glycyrrhiza glabra root extract Treatment in Wistar Albino Rats." Journal of natural science, biology, and medicine vol. 5,1 (2014): 25-9. doi:10.4103/0976-9668.127279
39. Chakravarthi, Kosuri Kalyan, and Ramakrishna Avadhani. "Beneficial effect of aqueous root extract of Glycyrrhiza glabra on learning and memory using different behavioral models: An experimental study." Journal of natural science, biology, and medicine vol. 4, 2 (2013): 420-5. doi:10.4103/0976-9668.117025
40. "Prepulse inhibition (PPI) disrupting effects of Glycyrrhiza glabra extract in mice: a possible role of monoamines." Neuroscience letters vol. 544 (2013): 110-4. doi:10.1016/j.neulet.2013.03.055
41. Hasanein, Parisa. "Glabridin as a major active isoflavan from Glycyrrhiza glabra (licorice) reverses learning and memory deficits in diabetic rats. Acta physiologica Hungarica vol. 98, 2 (2011):221-30.doi:10.1556/APhysiol.98.2011.2.14
42. Cui, Yong-Ming et al. "Effect of glabridin from Glycyrrhiza glabra on learning and memory in mice." Planta medica vol. 74, 4 (2008): 377-80. doi:10.1055/s-2008-1034319
43. Sharifzadeh, Mohammad et al. "A time course analysis of systemic administration of aqueous licorice extract on spatial memory retention in rats." Planta medica vol. 74, 5 (2008): 485-90. doi:10.1055/s-2008-1074494
44. Dhingra, Dinesh et al. "Comparative brain cholinesterase-inhibiting activity of Glycyrrhiza glabra, Myristica fragrans, ascorbic acid, and metrifonate in mice." Journal of medicinal food vol. 9, 2 (2006): 281-3. doi:10.1089/jmf.2006.9.281
45. Parle, Milind et al. "Memory-strengthening activity of Glycyrrhiza glabra in exteroceptive and interoceptive behavioral models." Journal of medicinal food vol. 7, 4 (2004): 462-6. doi:10.1089/jmf.2004.7.462
46. Dhingra, Dinesh et al. "Memory enhancing activity of Glycyrrhiza glabra in mice." Journal of ethnopharmacology vol. 91, 2-3 (2004): 361-5. doi:10.1016/j.jep.2004.01.016

47. Murck, Harald et al. "Adjunct Therapy With Glycyrrhiza Glabra Rapidly Improves Outcome in Depression-A Pilot Study to Support 11-Beta-Hydroxysteroid Dehydrogenase Type 2 Inhibition as a New Target." Frontiers in psychiatry vol. 11 605949. 10 Dec. 2020, doi:10.3389/fpsyt.2020.605949
48. Cho, Suengmok et al. "Hypnotic effects and GABAergic mechanism of licorice (Glycyrrhiza glabra) ethanol extract and its major flavonoid constituent glabrol." Bioorganic & medicinal chemistry vol. 20, 11 (2012): 3493-501. doi:10.1016/j.bmc.2012.04.011
49. Wang, Weixing et al. "Antidepressant-like effects of liquiritin and isoliquiritin from Glycyrrhiza uralensis in the forced swimming test and tail suspension test in mice." Progress in neuro-psychopharmacology & biological psychiatry vol. 32, 5 (2008): 1179-84. doi:10.1016/ j.pnpbp.2007.12.021
50. Dhingra, Dinesh, and Amandeep Sharma. "Antidepressant-like activity of Glycyrrhiza glabra L. in mouse models of immobility tests." Progress in neuro-psychopharmacology & biological psychiatry vol. 30, 3 (2006): 449-54. doi:10.1016/j.pnpbp.2005.11.019
51. Kazlauskaite, Jurga Andreja et al. "Application of Antiviral, Antioxidant and Antibacterial Glycyrrhiza glabra L., Trifolium pratense L. Extracts and Myristica fragrans Houtt. Essential Oil in Microcapsules." Pharmaceutics vol. 15, 2 464. 30 Jan. 2023, doi:10.3390/pharmaceutics15020464
52. Mutaillifu, Paiheerding et al. "Structural characterization and antioxidant activities of a water soluble polysaccharide isolated from Glycyrrhiza glabra." International journal of biological macromolecules vol. 144 (2020): 751-759. doi:10.1016/j.ijbiomac.2019.11.245
53. Frattaruolo, Luca et al. "Antioxidant and Anti-Inflammatory Activities of Flavanones from Glycyrrhiza glabra L. (licorice) Leaf Phytocomplexes: Identification of Licoflavanone as a Modulator of NF-kB/MAPK Pathway." Antioxidants (Basel, Switzerland) vol. 8, 6 186. 20 Jun. 2019, doi:10.3390/antiox8060186
54. Dal Bosco, Alessandro et al. "The antioxidant effectiveness of liquorice (Glycyrrhiza glabra L.) extract administered as dietary supplementation and/or as a burger additive in rabbit meat." Meat science vol. 158 (2019): 107921. doi:10.1016/j.meatsci.2019.107921
55. Aluckal, Eby et al. "Assessment of Total Antioxidant Capacity and Antimicrobial Activity of Glycyrrhiza glabra in Saliva of HIV-Infected Patients." Journal of pharmacy & bioallied sciences vol. 9, Suppl 1 (2017): S237-S240. doi:10.4103/jpbs.JPBS_141_17
56. Hejazi, Iram Iqbal et al. "New insights into the antioxidant and apoptotic potential of Glycyrrhiza glabra L. during hydrogen peroxide mediated oxidative stress: An in vitro and in silico evaluation." Biomedicine & pharmacotherapy = Biomedicine & pharmacotherapie vol. 94 (2017): 265-279. doi:10.1016/j.biopha.2017.06.108
57. Yin, Guojun et al. "Hepatoprotective and antioxidant effects of Glycyrrhiza glabra extract against carbon tetrachloride (CCl(4))-induced hepatocyte damage in common carp (Cyprinus carpio)." Fish physiology and biochemistry vol. 37, 1 (2011):209-16. doi:10.1007/s10695-010-9436-1
58. Visavadiya, Nishant P, and Amaravadi V R L Narasimhacharya. "Hypocholesterolaemic and antioxidant effects of Glycyrrhiza glabra (Linn) in rats." Molecular nutrition & food research vol. 50, 11 (2006): 1080-6. doi:10.1002/mnfr.200600063
59. Huang, Chunying et al. "Glycyrrhiza Polysaccharide Alleviates Dextran Sulfate Sodium-Induced Ulcerative Colitis in Mice." Evidence-based complementary and alternative medicine: eCAM vol. 2022 1345852. 8 Apr. 2022, doi:10.1155/2022/1345852
60. Yang, Yi et al. "Anti-ulcer effect and potential mechanism of licoflavone by regulating inflammation mediators and amino acid metabolism." Journal of ethnopharmacology vol. 199(2017):175-182.doi:10.1016/j.jep.2017.01.053
61. Mukherjee, Moumita et al. "Anti-ulcer and antioxidant activity of GutGard." Indian journal of experimental biology vol. 48, 3 (2010): 269-74.
62. Aly, Adel M et al. "Licorice: a possible anti-inflammatory and anti-ulcer drug." AAPS Pharm Sci Tech vol. 6, 1 E74-82. 20 Sep. 2005, doi:10.1208/pt060113
63. Khayyal, M T et al. "Antiulcerogenic effect of some gastrointestinally acting plant extracts and their combination." Arzneimittel-Forschung vol. 51, 7 (2001): 545-53. doi:10.1055/s-0031-1300078
64. Chowdhury, Bimalendu et al. "Anti-convulsant action and amelioration of oxidative stress by Glycyrrhiza glabra root extract in pentylenetetrazole- induced seizure in albino rats." Indian journal of pharmacology vol. 45, 1 (2013): 40-3. doi:10.4103/0253-7613.106433
65. Blumenthal M., Goldberg A., Brinckmann J., Foster S. American Botanical Council; Austin, TX: 2000. Herbal Medicine—Expanded Commission E Monographs. pp. 233–239
66. Blumenthal M., Goldberg A., Brinckmann J., Foster S. American Botanical Council; Austin, TX: 2000.

Herbal Medicine- Expanded Commission E Monographs. pp. 233–239

67. Bradley P.R., editor. vol. 1. British Herbal Association; Bournemouth: 1992. pp. 145–148. (British Herbal Compendium).
68. Armanini D., Fiore C., Matterello M.J., Bielenberg J., Palermo M. History of the endocrine effects of licorice. Experimental and Clinical Endocrinology & Diabetes. 2002; 110: 1–5.
69. Fuhrman B., Buch S., Vaya J., Belinky P.A., Coleman R., Hayek T., Aviram M. Licorice extract and its major polyphenol glabridin protect low-density lipoprotein against lipid peroxidation: in vitro and ex vivo studies in humans and in atherosclerotic apolipoprotein E-deficient mice. American Journal of Clinical Nutrition. 1997; 66: 267–275.
70. Mukherjee, Moumita et al. Anti-ulcer and antioxidant activity of GutGard. Indian journal of experimental biology vol. 48, 3 (2010): 269-74.
71. Fuhrman B., Volkova N., Kaplan M., Presser D., Attias J., Hayek T., Aviram M. Antiatherosclerotic effects of licorice extract supplementation on hypercholesterolemic patients: increased resistance of LDL to atherogenic modification, reduced plasma lipid level, and decreased systolic blood pressure. Nutrition. 2002; 18: 268–273.
72. Ross I.A. vol. 2. Humana Press; Totowa, NJ: 2001. Glycyrrhiza glabra. (Medicinal Plants of the World. Chemical Constituents, Traditional and Modern Medicinal Uses). pp. 191–240.
73. Sarokte, Atul Shankar, and Mangalagowri V Rao. "Effects of Medhya Rasayana and Yogic practices in improvement of short-term memory among school-going children." Ayu vol. 34, 4 (2013): 383-9. doi:10.4103/0974-8520.127720
74. Saeedi M., Morteza-Semnani K., Ghoreishi M.R. The treatment of atopic dermatitis with licorice gel. Journal of Dermatology Treatment. 2003; 14: 153–157.
75. Fujita H., Sakurai T., Yoshida M. Antiinflammatory effect of glycyrrhizinic acid: Effects of glycyrrhizinic acid against carrageenin-induced edema, UV-erythema and skin reaction sensitised with DNCB. Pharmacometrics. 1980; 19: 481–484.
76. Pei, Hongyan et al. "PI3K-Akt signaling pathway based on network pharmacology for the anti-Alzheimer's disease effect of licorice stem flavonoids." Aging vol. 15, 9 (2023): 3381-3393. doi:10.18632/aging.204536
77. Dhingra D, Sharma A (2006)\Antidepressant-like activity of Glycyrrhiyza glabra L. in mouse models of immobilitytests. Prog Neuropsychopharmacol Biol Psychiatry 30: 449-454
78. Kim SW, Jin Y, Shin JH, Kim ID, Lee HK, et al. (2012) Glycyrrhizic acid affords robust neuroprotection in the postischemic brain via anti-inflammatory effect by inhibiting HMGB1 phosphorylation and secretion. Neurobiol Dis 46: 147-156.
79. Adamyan TI, Gevorkyan ES, Minasyan SM, Oganesyan KR, Kirakosyan KA. (2005), Effect of licorice root on peripheral blood indexes upon vibration exposure. Bull Exp Biol Med. 140(2): pp 197–200
80. Reddy KY. Review on effect of natural memory enhancing drugs on dementia. Int J Phytopharm 2010; 1: 17.) Yastimadhu (Glycirrhiza glabra Linn.)
81. Reddy KY. Review on effect of natural memory enhancing drugs on dementia. Int J Phytopharm 2010; 1: 17.) Yastimadhu (Glycirrhiza glabra Linn.)
82. Khayyal, M T et al. "Antiulcerogenic effect of some gastrointestinally acting plant extracts and their combination." Arzneimittel-Forschung vol. 51, 7 (2001): 545-53. doi:10.1055/s-0031-1300078

Cite this article as:
Sushant Bhandari, Nisha Ojha. Therapeutic Effects of Glycyrrhiza Glabra Linn. International Journal of Ayurveda and Pharma Research. 2023;11(11):39-49.
https://doi.org/10.47070/ijapr.v11i11.2910
Source of support: Nil, Conflict of interest: None Declared

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