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REVIEW ARTICLE

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Advances in Pharmaceutical Preparations and Medicinal Potential of *Glycyrrhiza glabra*

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ABSTRACT

Glycyrrhiza glabra is one of the most important medicinal perennial herbs which belong to a family of Leguminosae. Glycyrrhizin (glycyrrhizic acid; glycyrrhizinate) is a primary active ingredient of *G. glabra* roots and the concentration of Glycyrrhizin is approx 10–25%. Somesaponin compound comprised of an aglyconetriterpenoid, glycyrrhetic acid (glycyrrhetinic acid; enoxolone) conjugated to a disaccharide of glucuronic acid. The medicinal properties present in *Glycyrrhiza glabra* is due to its active ingredients. The chapter emphasizes on the importance of *G. glabra* in Indian medical sciences. It is active against various diseases like anemia, gout, sore throat, tonsillitis, flatulence, sexual debility, hyperdypsia, fever and skin diseases so on. This chapter also highlighting the potential application of a plant-based medicine that may be used as an alternative method against various diseases. Other aspect which pointed on the use of this plant is because *Glycyrrhiza glabra* is not associated with any common side effects.

Keywords: Aglyconetriterpenoid, Glycyrrhetinic acid, Hyperdypsia and Sexual debility etc.

INTRODUCTION

Glycyrrhiza glabra Linn is one of the most widely used herbs from the ancient medical history. *Glycyrrhiza* word is derived from the prehistoric Greek term *glykos* (sweet) and *rhiza* (root). *Glycyrrhiza glabra* is an herbal medicine used across the world for its potential therapeutic effect and shows very less adverse reaction compared to the synthetic chemicals (Kataria et al 2013). More than 4000 years it has been used as an Ayurvedic medicine. Over the past thousand years liquorice has been known in Dispensary also mentioned in Assyrian herbal (2000BC). Approx. 400 BC Hippocrates used as a remedy of ulcers and quenching of Thirsts. Theophrastus and Dioscorides also cited the liquorice. In ancient Chinese dispensary, it was considered to first class drug and long-time consumption shows rejuvenating property. It was useful in allay thirst, feverishness, pain, cough and distress of breathing condition. For many times China used large quantities of liquorice in many preparations. It also frequently used medicine in susruta.

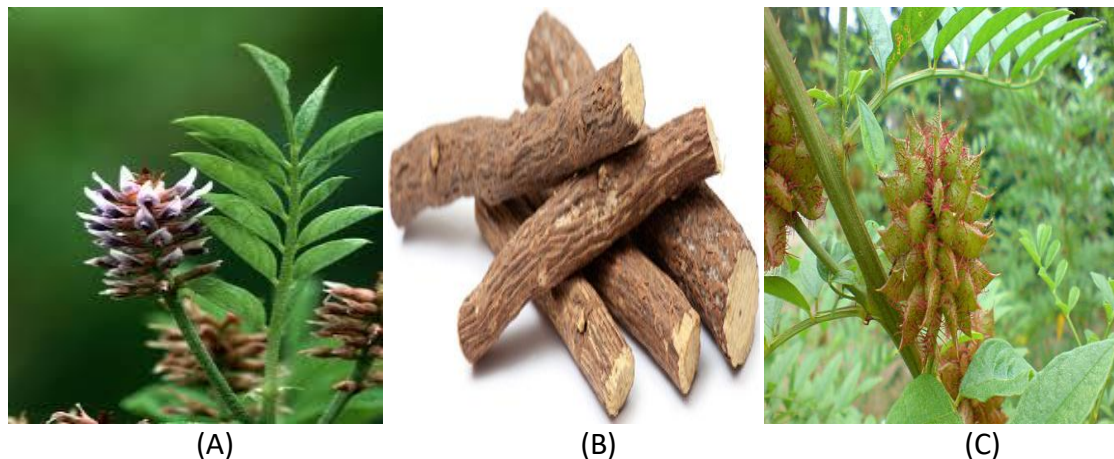


Figure 1. (A) Plant of *Glycyrrhizaglabra. L* (B) Roots (C) Fruit.

Classification

Kingdom: Plantae

Division: Angiospermae

Class: Dicotyledoneae

Order: Rosales

Family: Leguminosae

Genus: *Glycyrrhiza*

Species: *glabra* Linn

Glycyrrhiza is a genus and comprised of 20 accepted species. Some selected species are *Glycyrrhiza acanthocarpa*, *Glycyrrhiza aspera*, *Glycyrrhiza astragalina*, *Glycyrrhiza bucharica*, *Glycyrrhiza echinata*, *Glycyrrhiza eglandulosa*, *Glycyrrhiza foetida*, *Glycyrrhiza foetidissima*, *Glycyrrhiza glabra* – liquorice, liquorice, *Glycyrrhiza gontscharovii*, *Glycyrrhiza iconica*, *Glycyrrhiza inflata*, *Glycyrrhiza korshinskyi*, *Glycyrrhiza lepidota* – American liquorice, *Glycyrrhiza pallidiflora*, *Glycyrrhiza squamulosa*, *Glycyrrhiza triphylla*, *Glycyrrhiza uralensis*, *Glycyrrhiza yunnanensis*.

Common Names: Sanskrit Name: Yashti-madhuh, Madhuka, Bengali Name: Jashtimadhu, Jaishbomodhu, Gujrati Name: Jethimadhu, Hindi Name: Jothi-madh, Mulhatti, Yastimadhuka, Kannad Name: Atimaddhura, Malyaalam Name: Iratimadhuram, Marathi Name: Jeshtamadha, Oriya Name: Jatimadhu, Tamil Name: Atimaduram, Telugu Name: Atimadhuranu, Yashtimadhukam, English Name: Liquorice, licorice and Sweet wood (Chopra et al 2002).

Morphology

Habitat: It is a perennial medicinal herb basically grows in Subtropical Environments. In India the plant is cultivated in Punjab and sub Himalayan region. It has 4-5 feet height.

Leaves: The leaves are compound, imparipinnate, alternate, having 4-7 pairs of oblong, elliptical or lanceolate leaflet.

Flowers: Purplish white flower clusters, typically papilionaceous, borne in axillary spikes. The calyx is small, campanulate, with lanceolate tips and bearing glandular hairs.

Fruits: The fruit is a flattened legume or pod, upto 1.5 cm long, erect, glabrous, slightly reticulate pitted, and usually contains 3-5 brown, reniform seeds.

Roots: Below ground it has an extensive root system with a main taproot and numerous runners. The harvested taproot is soft, fibrous, and has a bright yellow interior.

Active Constituent

Various water soluble biological active compound found in 40-50% of total dry weight of *Glycyrrhiza glabra*. Basically it contains Starches (30%), pectins, polysaccharides, simple sugars, gums, mucilage (Rhizome), amino acids, triterpenesaponin, flavonoids, mineral salts, bitters, essential oil, fat, asparagines, female hormone estrogen, tannins, glycosides, protein, resins, sterols, volatile oils. (Bradley et al 1992, Hoffmann et al 1990). Glycyrrhizin (glycyrrhizic acid; glycyrrhizinate) is a primary active ingredient of *G. glabra* roots the concentration of Glycyrrhizin is approx 10–25%. Saponin compound comprised of an aglycone triterpenoid, glycyrrhetic acid (glycyrrhetic acid; enoxolone) conjugated to a disaccharide of glucuronic acid. It is 60 times much sweeter than cane sugar. Originally its activity and structure were analogous to adrenal steroid hormones such as Aldosterone and cortisol; subsequently ingestion of liquorice mimicked hyperaldosteronism. In future, it will be also used in the treatment of some other diseases like Addison's disease.

Glycyrrhizin and glycyrrhetic acid can exist in 18 α and 18 β stereoisomer (Food Chemicals Codex 2003). Glycyrrhizin most commonly used as an anti-inflammatory agent on neutrophil functions including ROS (reactive oxygen species) generation in Asia as a folk medicine (Rahman et al 2007). It is also used for the quenching of free radicals basically in lipid peroxidation chain reactions. Some group also reported that it is showing the property of a chemo preventive, antioxidant, and anti-proliferative activity in animal model (Rahman et al 2007). Carbenoxolone which is an analog of glycyrrhetic acid, (18- β glycyrrhetic acid hydrogen succinate) is useful in peptic ulcers treatment of alimentary tract (ulcerative conditions in alimentary canal). (Isbrucker et al 2006). This shows that *G. glabra* active compounds show a broad range of importance which opens a new door for the pharmaceutical industries.

Flavonoid like liquiritin, isoliquirtin, liquiritigenin, rhamnoliquiritin and five new flavonoids-glucoliquiritinapioside, shinflavanone, shinpterocarpin, prenyllicoflavone A, 1-methoxyphaseolin have been isolated from dried roots of liquorice and responsible for its yellow color (Yamamura et al 1992, Wealth of India 2005). Some isoflavones like glabridin and hispaglabridins A and B show antioxidant activity. One another important fact is that both the glabridin and glabrene mimic the activity of estrogen (Vaya et al 1997). 2-methyliso – flavones and C liquocoumarin, 6 - acetyl- 5, hydroxy-4- methylcoumarin (unusual coumarin), Asparagine is also reported in Indian variety of liquorice roots (Li et al 2001). Some volatile compounds like geraniol, pentanol, hexanol, terpinen-4-ol, α -terpineol and other compounds such as propionic acid, benzoic acid, furfuraldehyde, 2,3 butanediol, furfurylformate, maltol, 1-methyl-2-formylpyrrole, trimethylpyrazine were isolated from essential oil (Tamir et al 2001).

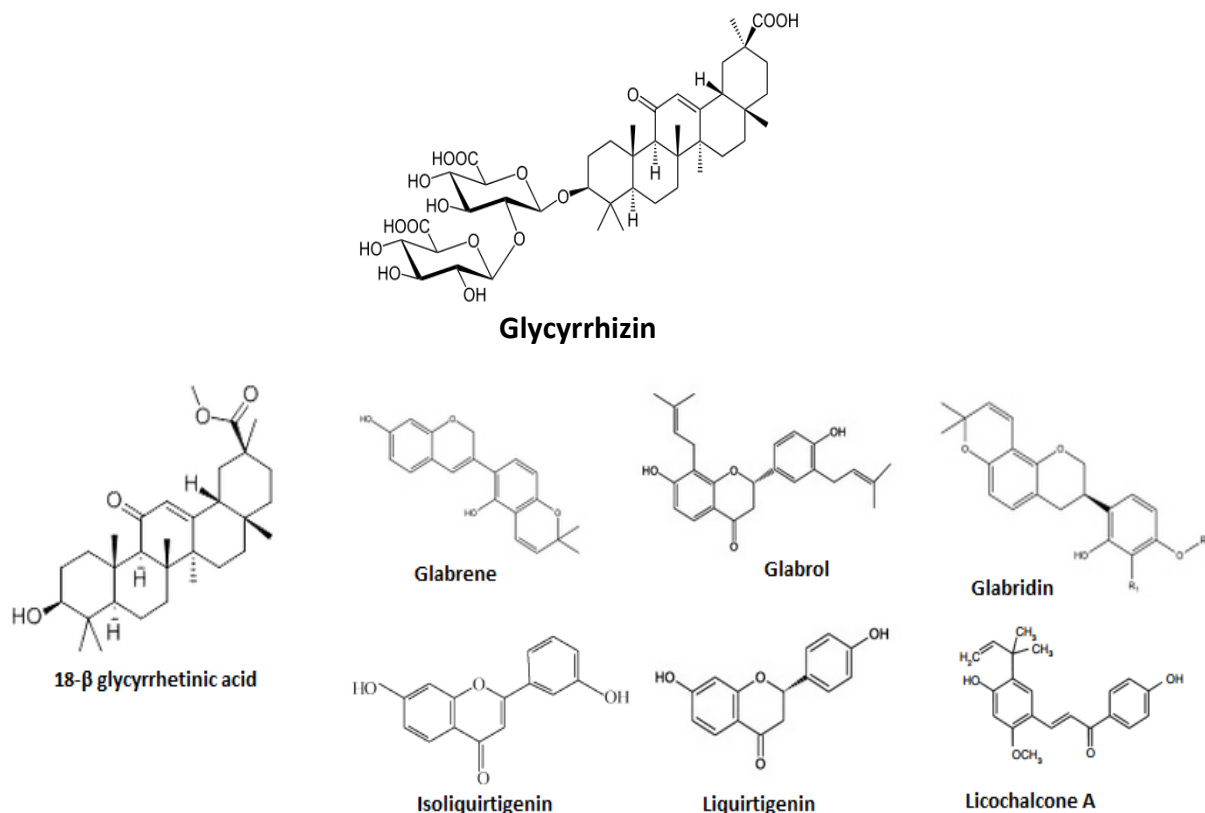


Figure. 2 Chemical structure of some active ingredients of *G. glabra*.

Traditional Uses

G. glabra used as a prophylactic agent for gastric and duodenal ulcer and also employed in dyspepsia as an anti-inflammatory agent during allergic reaction. (Ammosov et al 2003). In folk therapy it is used as an antiviral agent, anti-asthmatic, laxative, contraceptive, emmenagogue, galactagogue etc. (Saxena et al 2005) liquorice roots are very useful for treating cough treatment due to its demulcent and expectorant property (Openmed 2005). It is also effective against various diseases like anemia, gout, sore throat, tonsillitis, flatulence, sexual debility, hyperdyspsia, fever, skin diseases, swellings etc and effectively used in acidity, leucorrhoea, bleeding, jaundice, hiccup, hoarseness, bronchitis, vitiated conditions of Vatadosha, gastralgia, diarrhea, fever with delirium and anuria (Seth et al 2005, Kaur et al 2013). Their oily preparation used for the treatment of rheumatism, hemorrhagic diseases, epilepsy and paralysis. (Kaur et al 2013). The main active ingredient glycyrrhizin used in the treatment of chronic hepatitis and liver cirrhosis also used as a demulcent in catarrh of the genitourinary passages (Nadkarni et al 1976).

Pharmacological Activity

Expectorant and Antitussive property

Extract of liquorice was effective in sore throat, cough and bronchial catarrh, capsaicin and SO₂ gas induced cough. It also helps in reducing irritation and act as a demulcent, expectorant by stimulating tracheal mucus secretion producing demulcent and effects.

A semi synthetic compound Carbenoxolone stimulates gastric mucus secretion. Glycyrrhizin is responsible for demulcent action of liquorice (Murray et al 1998, Kamei et al 2003, Jahan et al 2012).

Antioxidant Activity

Ethanollic extract of Liquorice (*Glycyrrhiza glabra L*) contain high phenolic content which is act as a powerful antioxidant by means of potentially free radical scavenging, hydrogen-donating, metal ion chelating, anti-lipid peroxidative and reducing abilities (Visavadiya et al 2009). Liquorice Flavonoids shows 100 times much stronger antioxidant activity as compare to vitamin E (11.2% scavenging). A dose of 2.58 mg/ml liquorice flavonoids can scavenge more free radicals (20.6% scavenging) than 258 mg/ml of vitamin E (11.2% scavenging) (Ju et al 1989). Liquorice extract used as one formulation in cosmetic products for the protection of oxidative induce skin and hair damage (Alonso et al 2004).

Skin Pigment Lightening and Tightening

Hydrophobic Fraction of liquorice extracts contains glabirin which inhibit tyrosinase activity in cultured melanoma cells of murine. Glabrene, Licochalcone A, Isoliquiritin are also responsible for inhibition of tyrosinase activity. Some active compound like Liquiritin present in liquorice extracts disperses melanin; in this manner which induces skin tightening (Cronin et al 2010). Ethanollic extract of liquorices improve the viscoelastic and hydration properties of the skin.

Anti-inflammatory Activity

Glycyrrhetic acid mimics the effect like glucocorticoids and mineralocorticoids (Baker et al 1994). Glycyrrhizic acid inhibits prostaglandin formation (specifically prostaglandin E2) as well as cyclooxygenase activity and indirectly inhibits the platelet aggregation (Okimasu et al 1983, Ohuchi et al 1982). A glycyrrhetic acid analog Carbenoxolone (Biogastron) inhibit two main enzymes that are important in prostaglandin metabolism 1) 15-hydroxyprostaglandin dehydrogenase and 2) Δ 13 prostaglandin.

Antiviral Effect

Glycyrrhizin shows antiviral activity by inhibiting cell binding and control the viral replication. It terminates latent infection of Kaposi Sarcoma associated herpes virus by down regulating the expression of LANA in B lymphocyte. It is also useful against various viruses including herpes simplex, Varicella zoster, and of Japanese encephalitis, influenza virus, vesicular stomatitis virus, type A influenza virus (Alonso et al 2004, Adam et al 1997, Pompei et al 1980, Pompei et al 1979)

Antifungal and Antibacterial Effect

Isoflavonoids like glabridin, glabrol and its derivatives are used in the *in vivo* inhibition of *Mycobacterium smegmatis* and *Candida albicans*. Extraction in various solvent of liquorice show inhibitory effect on *Staphylococcus aureus* and *Streptococcus pyogenes* cultures (Alonso et al 2004).

Anti-malarial activity

It is well known Antimalarial effect against *P. yoelii* in mice. *In vivo* studies Licochalcone A (a chalcone) eradicate malarial parasite completely without showing any toxic effect (Sianne et al 2002).

Anti-hyperglycemic activity

Liquorice extract potentially used for lowering the serum lipid content and other liver enzymes (Revers et al 1956).

Immunostimulatory effects

100µg/ml concentration of liquorice extract increases the production of TCD69 lymphocytes and macrophages from human granulocytes. It also prevents the production of immune-complexes related to autoimmune diseases like systemic lupus erythematosus (SLE) (Alonso et al 2004). Glycyrrhizin decreases IgG and IgA which play essential role in hypersensitivity mechanism. It inhibit type I hypersensitivity reaction induced by ascarislumbricoides containing serum.

Memory enhancing activity

Successive administration of 7 days of 150 mg/kg p.o of aqueous extract of liquorice may improve memory and learning ability in mice. Scopolamine induced amnesia was reversed by liquorice it is possible that the beneficial effect of learning and memory was due to facilitation of cholinergic transmission in mouse brain also effective in Diazepam induced amnesia (Dhingra et al 2004).

Hepatoprotective effect

Glycyrrhizin shows hepatoprotective effect against CCl₄. It inhibits CCl₄ induced release of AST and LDH at various concentrations between of 25–200 µg/ml. and widely used membrane lipid peroxidation caused by CCl₄. Other active compound 18β-glycyrrhetic acid significantly inhibits both radical generation and lipid peroxidation (Jeong et al 2002). Liquorice extract (Glycyrrhizin) is useful in diclofenac and acetaminophen-induced hepatotoxicity (Ying et al 2009, Alaaeldin et al 2007).

Anticoagulant effect

Glycyrrhizin induced platelet aggregation without affecting the Platelet Aggregating Factor (PAF) and Collagen induced agglutination (Mauricio et al 1997, Mendes-Silva et al 2003). It also increases plasma recalcification duration.

Stimulatory effect on hair

2% liquorice extract shows better stimulatory result as comparison to 2% Minoxidil without causing any irritation & sensitivity and it can be safely used in various types of hair problems like Alopecia (Roy et al 2014).

Dosage and Administration

The acceptable daily intake (ADI) for glycyrrhizin is 0.2 mg/kg/day. Long-time duration of high dose of liquorice roots possess high risk of hyperkalemia. Daily use of 2-15 g liquorice root used in the treatment of ulcer and gastritis.

Side effect and Safety

Oral intake of liquorice is a safest route for drug administration; in the treatment of various diseases the quantity would be large for better result. But large amount for more than 4 weeks or in smaller amounts long-term causes severe side effect like high blood pressure, low potassium levels, weakness, paralysis, and occasionally brain damage, other side effects of liquorice use include tiredness, absence of a menstrual period in women, headache, water and sodium retention, and decreased sexual interest and function in men.

Precaution and warnings

Pregnancy and breast-feeding: 250 grams per week consumption of liquorice during pregnancy, seems to increase the risk of early delivery. It potentially causes a miscarriage. There is not enough evidence found about the safety of infant taking liquorice during breast feeding.

Heart disease: Liquorice increase body water accumulation and increases the risk of irregular heartbeat.

Hormone-sensitive conditions such as breast cancer, uterine cancer, ovarian cancer, endometriosis, or uterine fibroids (Liquorice mimic estrogen in the body) can also occur.

A muscle condition caused by nerve problems (hypertonia): Liquorice drops the potassium level in the blood which induces hypertonia.

Low potassium levels in the blood (hypokalemia): Liquorice can decrease potassium level in the blood. If your potassium is already low, liquorice might make it too low. In such condition avoid the use of liquorice.

Sexual problems in men: Liquorice can lower a man's interest in sex and also worsen erectile dysfunction (ED) by lowering levels of a hormone called testosterone.

Surgery: Liquorice might interfere with blood pressure control during and after surgery. Stop taking liquorice at least 2 weeks before a scheduled surgery.

CONCLUSION

The story of herbal drug is always subject of interest. *G. glabra* is kind of medicinal plant which facilitates their use during various diseases. Day by day the medicinal use of this plant is going to be broadening the horizon of pharmaceutical industries. Several active ingredients of *G. glabra* like glycyrrhizin, glabridin, glabrol etc. used for the different purposes and proved as a best remedy. This proved that the *G. glabra* is full of medicinal application and create a new way in search of other application of this plant.

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REFERENCES

- Adam, L. (1997).** *In vitro* antiviral activity of indigenous glycyrrhizin, liquorice and glycyrrhizic acid (Sigma) on Japanese encephalitis virus. *J Commun Dis*; 29 (2):91-99.
- Alaaeldin, A.H. (2007).** *Curcuma longa*, *Glycyrrhizaglabra* Linn and *Moringaoleifera* Ameliorate Diclofenac-induced Hepatotoxicity in Rats. *American J Pharmacology and Toxicology*; 2(2): 80-88.

- Alonso, J. (2004).** Tratado de Fitofármacos y Nutracéuticos. www.fitoterapia.net. Barcelona: *Corpus*, 905-911.
- Ammosov, S. and Litvinenko, V.I. (2003).** Triterpenoids of Plants of *Glycyrrhiza* L. and *Meristotropis* Fisch. Et Mey Genuses, *Pharm Chem J*; 37:83-94.
- Baker, M.E. (1994).** liquorice and enzymes other than 11- hydroxysteroid dehydrogenase: An evolutionary perspective, *Steroids*; 59:136-141.
- Bradley, P.R. (1992).** British Herbal Compendium, 1, BHMA, Bournemouth.
- Chopra, R.N., Nayar, S.L. and Chopra, I.C. (2002).** Glossary of Indian Medicinal Plants. New Delhi, NISCAIR, CSIR.
- Cronin, H. and Draelos, Z.D. (2010).** Top 10 botanical ingredients in 2010 anti-aging creams. *Journal of Cosmetic Dermatology*; 9(3):218-225.
- Dhingra, D., Parle, M. and Kulkarni, S.K. (2004).** Memory enhancing activity of *Glycyrrhiza glabra* Linn in mice. *J Ethnopharmacology*; 91(2-3):361-365.
- Food Chemicals Codex (2003).** Edn 5, National Academy Press, Washington DC, 25.
- Glycyrrhiza* final. <http://openmed.nic.in/3195/01/>. 10 May 2014.
- Hoffmann, D. (1990).** The New Holistic Herbal, Edn 2, Element, Shaftesbury.
- Isbrucker, R.A. and Burdock, G.A. (2006).** *Regulatory Toxicology and Pharmacology*, 46: 167-192.
- Jahan, Y. and Siddique, H.H. (2012).** Study of anti tussive potential of *Glycyrrhiza glabra* and *Adhatoda vasica* using a cough model induced by SO₂ gas in mice, *International Journal of Pharmaceutical Sciences and Research*; 3:1668-74.
- Jeong, H.G., You, H.J., Park, S.J., Moon, A.R., Chung, Y.C., Kang, S.K. et al. (2002).** Hepatoprotective effects of 18 β - glycyrrhetic acid on carbon tetrachloride-induced liver injury: inhibition of cytochrome P450 2E1 expression, *Pharmacological Research*; 46:221-227.
- Ju, H.S., Li, X.J., Zhao, B.L., Han, Z.W. and Xin, W.J. (1989).** Effects of Glycyrrhiza Flavonoids on lipid peroxidation and activeoxygen radicals. *Acta Pharmaceutica Sinica*; 24 (11): 807-812.
- Kamei, J., Nakamura, R., Ichiki, H. and Kubo, M. (2003).** Antitussive principles of *Glycyrrhiza radix*, a main component of Kampo preparations Bakumondo-to (Mai-men-dongtang). *E J Pharm*; 69:159-163.
- Kataria, R., Hemraj Singh, G., Gupta, A., Jalhan, S., Jindal, A. et al. (2013).** Pharmacological activities on *Glycyrrhiza glabra*—A review, *Asian J Pharm Clin Res*; 6(1):5-7.
- Kaur, R., Kaur Dhinds, A.S. (2013).** *Glycyrrhiza glabra*: A phytopharmacological review, *IJPSR*; 4(7):2470- 2477.
- Li, W., Asada, Y. and Yoshikawa, T. (2000).** Flavonoid constituents from *Glycyrrhizaglabra* Linn hairy root cultures, *Phytochemistry*; 55(5):447-56.
- Mauricio, I., Francischetti, B., Monterio, R.Q. and Guimaraes, J.A. (1997).** Identification of *Glycyrrhizin* as thrombin inhibitor, *Biochim Biophys Res Commun*; 235:259-263.
- Mendes-Silva, W., Assafim, M., Ruta, B., Monteiro, R.Q., Guimaraes, J.A., Zingali, R.B. et al. (2003).** Antithrombotic effect of *Glycyrrhizin*, A plant-derived thrombin inhibitor, *Thromb Res*; 112:93-98.
- Murray, W.J. (1998).** Herbal Medications for Gastrointestinal Problems, Herbal Medicinals- A Clinician's Guide, *Pharmaceutical Products Press*, New York, 79-93.

- Nadkarni, K.M. (1976). Indian Materia Medica, Popular Prakashan Pvt. Ltd., Mumbai, 582-4.
- Ohuchi, K. and Tsurufuji, A. (1982). A study of the anti-inflammatory mechanism of glycyrrhizin. *Mino Med Rev*; 27:188- 193.
- Okimasu, E., Moromizato, Y. and Watanabe, S. (1983). Inhibition of phospholipase A2 and platelet aggregation by glycyrrhizin, an anti-inflammatory drug. *Acta Med Okayama*; 37:385-391.
- Pompei, R., Flore, O., Marcialis, M.A., Pani, A. and Loddò, B. (1979). Glycyrrhizic acid inhibits virus growth and inactivates virus particles, *Nature*; 281(5733):689-90.
- Pompei, R., Pani, A., Flore, O., Marcialis, M.A. and Loddò, B. (1980). Antiviral activity of glycyrrhizic acid. *Experientia*; 36:304.
- Rahman, S. and Sultana, S. (2007). Glycyrrhizin exhibits potential chemopreventive activity on 12-Otetradecanoylphorbol- 13-acetate-induced cutaneous oxidative stress and tumor promotion in Swiss albino mice. *Journal of Enzyme Inhibition and Medicinal Chemistry*; 22(3):363-369.
- Revers, F.E. (1956). Clinical and pharmacological investigations on extract of liquorice. *Acta Medica Scandinavica*; 154:749-751.
- Roy, S.D., Karmakar, P.R., Dash, S., Chakraborty, J. and Das, B. (2014). Hair growth stimulating effect and phytochemical evaluation of hydro-alcoholic extract of *Glycyrrhiza glabra*, *Global J res Med Plants and Indigen Med*; 3(2):40-47.
- Saxena, S. (2005). *Glycyrrhiza glabra*: Medicine over the millennium, *Natural product radiance*; 4 (5):358-367.
- Sheth, A. (2005). The Herbs of India. Edn 1, Vol 2, Hi Scan Pvt Ltd, Gujrat, 2005, 566.
- Sianne, S. and Fanie, R.V.H. (2002). Antimalarial activity of plant metabolites. *Nat Prod Rep*; 19: 675 692.
- Tamir, S., Eizenberg, M. and Somjen, D. (2001). Estrogen like activity of glabrene and other constituents isolated from liquorice root. *J Steroid Biochem Mol Biol*; 78:291-298.
- The Wealth of India (2005). A Dictionary of Indian Raw Materials and Industrial Products, First supplement series, National Institute of Sciences Communication and Information Resources, Vol 3, CSIR, New Delhi, D-1, 195-198.
- Vaya, J., Belinky, P.A. and Aviram, M. (1997). Antioxidant constituents from liquorice roots: isolation, structure elucidation and antioxidative capacity toward LDL oxidation, *Free Radic Biol Med*; 23:302-313.
- Visavadiya, N.P., Soni, B. and Dalwadi, N. (2009). Evaluation of antioxidant and anti-atherogenic properties of *Glycyrrhiza glabra* root using *In vitro* models. *International Journal of Food Sciences and Nutrition*; 60(2):135-149.
- Xu-ying, W., Ming, L., Xiao-dong, L. and Ping, H. (2009). Hepatoprotective and anti hepatocarcinogenic effects of glycyrrhizin and matrine. *J Chemico-Biological Interactions*; 181(1):15-19.
- Yamamura, Y., Kawakami, J. and Santa, T. (1992). Pharmacokinetic profile of glycyrrhizin in healthy volunteers by a new high-performance liquid chromatographic method. *J Pharm Sci*; 81:1042-1046.

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