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Review

Licorice (*Glycyrrhiza* spp.) in Health and Disease: A Minireview of Traditional Uses and Therapeutic Activities

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Abstract

Throughout history, human beings have utilized animals, minerals and plants for various purposes including use of them as foods and remedies. The distribution of plants, animals and minerals varies across different regions of the world; however, we can find same species or closely related varieties in different geographical areas. Based on different historical and cultural circumstances, these plants exhibit diverse therapeutic applications. Licorice (*Glycyrrhiza* spp.) as an ancient plant with long history of therapeutic uses is noticeable among traditional medicine of various cultures. Respectively, licorice is found in traditional medicines of Iran, India, Thailand and Korea and is recommended for respiratory, gastrointestinal, cardiovascular, and musculoskeletal problems. In modern medicine diverse beneficial effects of licorice has been shown by researches. Licorice effects on oral complications, dyspepsia, dental and gingival problems, non-alcoholic fatty liver disease, and polycystic ovarian syndrome are examples of its positive role in human health. Considering the inhibitory effect of licorice on 11-β-hydroxysteroid dehydrogenase enzyme type 2, pseudohyperaldosteronism may occur in case of long-term use of high doses and therefore, should be used with caution in susceptible patients. In spite of all the researches on licorice, it seems more clinical trials are needed to further confirm the therapeutic effects on this medicinal plant based on the traditional applications.

Keywords: Liquorice; Complementary and alternative medicine; Persian medicine; Thai traditional medicine; Unani medicine

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Introduction

Licorice is one of the numerous plants mentioned in traditional medicine texts from various cultures. This plant, with the scientific name *Glycyrrhiza* spp., belongs to the Fabaceae family and has different varieties and subspecies. Some of the most common species include *G. glabra*, *G. korshinskyi*, and *G. uralensis* [1]. The name *Glycyrrhiza* is coined by ancient Greek botanist Dioscorides which means sweet (Glycos) root (Rhiza) [2].

Licorice is native to parts of Europe and Asia, including the Mediterranean region, Central Asia, and parts of the Middle East [3].

Different varieties of licorice have various characteristics and varying levels of specific constituents. The most important phytochemicals extracted from licorice are triterpene saponins and flavonoids. Most of the pharmacological activities of licorice are attributed to these compounds. Glycyrrhizin is the main components of the licorice root which is composed of calcium, potassium, and magnesium salts of glycyrrhizic acid and constitute about 10% of the dry weight of the roots. This compound is a natural sweetener and is about 50 times sweeter than sugar and is therefore used as a substitute of sugar in confectionary [4]. On the other hand, flavonoids and isoflavones such as liquiritigenin, liquiritin, licoisoflavone B, glabridin, glabrene, formononetin, and glabrol constitute another important category of secondary metabolites in this plant which are responsible for the light-yellow color of the roots and have represented significant antioxidant and anti-inflammatory effects [5,6]. Other constituents found in licorice include coumarins like herniarin, licocoumarone, and umbelliferone.

The roots and stolons of licorice are recognized as its primary medicinal parts and are used for various therapeutic purposes in both traditional and modern medicine. These parts are known for several properties, including anti-inflammatory, demulcent and expectorant effects. Additionally, they are used in the treatment of gastrointestinal, respiratory, and dermatological disorders [7].

In this article, an overview is provided on the therapeutic uses of licorice in traditional medicines of different countries, along with a summary of the clinical evidence on the health benefits of this plant.

Licorice in traditional medicines

Licorice in traditional Persian medicine

Licorice is a well-known herbal remedy in Persian medicine that is used in many cases. Its temperament (nature) is dry in the first degree and hot in the second degree.

It affects many organs in the body such as stomach, spleen, lung, bladder, liver, nerve, and skin. Also, Persian medicine scientists used root of licorice more than the other parts, such as leaves and seeds, individually or in combination with other medicinal plants to cure diseases.

It is an abstergent (*Monzej*) of thick and compound humors and purgative (*Moshel*) of moisture. It is a nerve tonic and is recommended for neurological diseases especially headache. If administered as a topical eye drop, it can enhance eyesight.

In case of respiratory diseases, licorice reduces voice hoarseness and throat dryness. It works very effectively in most different types of coughs and decreases throat and lung irritation. It can treat sore throat, asthma, and shortness of breath and is known as a golden medicine for respiratory problems.

Licorice is repeatedly mentioned as a digestive medicine in Persian medicine books. It is known as a tonic for the stomach, liver and spleen. It can reduce stomach inflammation, swellings and burning sensation in stomach and relief thirst.

In urogenital system, licorice is known as a diuretic and recommended for bladder diseases.

Also, it is mentioned that long-term intake of licorice decoction with sugar and fennel improves facial skin color, chronic fevers, and migraine headaches, especially if taken during the spring.

Licorice root is better to be peeled before use. For oral intake, licorice is recommended in the form of decoction. Also, the concentrated extract of licorice or the so-called *Rob-al-Sus* in Persian medicine can be prepared via boiling licorice root in hot water, filtering the aqueous extract and evaporating the residual water until the extract turns into a thick and solid material.

In view of Persian medicine, licorice may cause some side effects in kidney and spleen and to reduce these side effects, it is better to be formulated together with tragacanth and damask rose [8-10].

Licorice in Indian traditional medicine

Licorice (*G. glabra*) is known as *Aslus-soos/Mulethi* and *Yashtimadhu* in Unani (Greek) and Ayurvedic Indian systems of medicine, respectively. Although it is widely used and has increasing demand in Indian traditional medicine, its cultivation is limited mainly to few places of India (Punjab, Kashmir and sub-Himalayan regions) and therefore, it is imported into India on a considerable scale from Iran, Iraq and other central Asian countries [11]. Its peeled roots are recommended for medicinal use by Unani physicians in India, believing its outer fibrous layer has got strong emetic properties [12]. In Unani and Ayurvedic medicine it is used in the form of powder, decoction, infusion and lozenges. Its extract is sold in the Indian market as *Rubbus soos* or *Sat Mulethi* [11]. The reported pharmacological actions of its root are tonic, alternant (making the consistency of viscid humors

to their optimum level), emetic, diuretic, demulcent, mild laxative, aphrodisiac, expectorant, emmenagogue, detergent, anti-stress, anti-inflammatory and neuroprotective properties. Owing to these effects, it is used in hyperdipsia, paralysis, cough, bronchitis, hoarseness of voice, vitiated conditions of phlegm and black bile humors, migraine, stomachache, fever, gastric ulcer, oral ulcer, hemorrhoid, eye and skin diseases [2,13-15]. It is also useful in irritable conditions of mucus membrane of urinary tract and is believed to enhance the effects of other medicinal herbs recommended for hepatic disorders. Its powder with milk is recommended for excessive spermatorrhea and nocturnal emission in young adults due to increased sensitivity. Taking licorice with fennel and sugar is believed to improve the complexion of face and relieves flatulence. Its powder mixed with honey is prescribed to allay the hiccups. The decoction of root is good as hair wash for premature falling and graying of hairs. Externally, the powdered root mixed with wax and honey is applied for cuts, wounds, alopecia and paronychia. Dioscorides recommended instillation of licorice extract in Pterygium [16,17]. Washing eyes with licorice decoction is thought to improve the vision [12,16,18]. Due to its sweet taste and throat soothing properties, roots of licorice are chewed with betel leaf as mouth freshener in India [11].

Since most of the mentioned actions and the medicinal uses of licorice in Indian system of medicine are based on the experiences from the ancient physicians, its proper validation using reliable scientific parameters is the need of hour to convert these important experiences into concrete evidences which will promote its safe, effective and rational use among the practitioners and its wider acceptance across the globe.

Licorice in Thai traditional medicine

Licorice root has a long history of use in Thai traditional medicine (TTM), as documented in the scriptures from the reign of King Narai the Great of the Ayutthaya Kingdom (1656-1688 A.D.). The Thai name "cha-em-thet" is derived from the words "choeem" (sweet) and "thet" (foreign), indicating its exotic origins [19].

In Thai traditional pharmacy, the taste of an herb plays a crucial role in its therapeutic application. Licorice root, known for its distinct sweet flavor, is traditionally believed to promote the water element (TTM body element concept) and provide moisturizing benefits, rejuvenating both the skin and body. It is also recognized for its actions as a muscle and cardiac tonic and its ability to soothe dry coughs [20].

Thai folk healers and traditional practitioners have long acknowledged the medicinal potential of various parts of the licorice plant. The fruit is traditionally used to nourish the body, soothe a dry throat, and support heart health. The leaves are thought to dry phlegm and alleviate internal heat. The flowers are reputed to provide relief from itching and abscesses. However, the root remains the most commonly used part, traditionally employed to nourish the heart, alleviate coughs, and soothe sore throats. It also serves as a flavoring agent and a mild laxative for children [21,22].

In TTM, licorice is rarely used on its own. Instead, it is typically combined with other herbs in complex formulas that work synergistically to achieve the desired therapeutic effects. Ancient texts and the Thailand National List of Essential Medicine for Herbal Medicines primarily recommend licorice for treating coughs, soothing sore throats, and reducing phlegm, while also promoting heart health, relieving fatigue, and balancing the flavors in a formula [19,21,23]. A prime example of licorice's role in TTM is its inclusion in Ummaruekvati (ยาอำมฤควาที), a well-known cough remedy where it constitutes a substantial 50% of the formula [23]. The safe and effective use of licorice in TTM requires a thorough understanding of herbal formulation principles. This knowledge ensures that the complex interactions among the herbs in a formula result in the best possible therapeutic benefits while minimizing potential side effects.

Licorice in Korean traditional medicine

Licorice, a perennial flowering plant in the Fabaceae family, holds a special place in Korean traditional medicine, known as Hanbang. Renowned for its wide-ranging therapeutic properties, licorice has been a key component of herbal remedies for centuries. In Korean culture, licorice is not just a flavoring agent, but a powerful medicinal herb valued for its diverse applications in treating various ailments. Its use in Korean traditional medicine can be traced back thousands of years, with roots in ancient texts such as the Donguibogam, a comprehensive medical encyclopedia written by the royal physician Heo Jun in the 17th century. Licorice was esteemed for its ability to harmonize the effects of other herbs, enhance their efficacy, and alleviate toxicity. Its revered status in Korean herbalism endures to this day, with modern practitioners continuing to harness its therapeutic potential.

Licorice has long been valued in Korean traditional medicine for its digestive benefits. It is often recommended to ease gastrointestinal discomfort such as indigestion, gastritis, and ulcers.

In Korean traditional medicine, licorice is commonly used to treat respiratory ailments like coughs, colds, and bronchitis. Its expectorant and demulcent properties can ease congestion, soothe sore throats, and help clear phlegm. Additionally, licorice is thought to regulate immune responses, potentially lessening the severity and duration of respiratory illnesses.

Licorice is highly regarded for its powerful anti-in-

flammatory properties, making it a valuable therapeutic tool in Korean traditional medicine.
In Korean traditional medicine, licorice is highly valued for its hepatoprotective properties, which are beneficial for maintaining liver health and treating liver disorders.
Licorice continues to play a vital role in promoting holistic well-being and treating a myriad of ailments. As the legacy of Korean herbalism endures, licorice remains an indispensable herbal remedy, cherished for its healing potential and profound contributions to human health [24-28].

Current evidence on the pharmacological and therapeutic effects of licorice

Oral disorders

Licorice has been considered as a valuable plant for oral health [29]. Oral mucositis is a complication caused by several pathologic conditions such as hemodialysis, cancer chemotherapy and radiotherapy of head or neck. In a randomized controlled trial (RCT) in hemodialysis patients with xerostomia, licorice mouthwash showed healing effect via increase in saliva flow rate and xerostomia relief [30]. Also, results of two RCTs indicate that mucoadhesive formulations containing licorice are helpful for the management of patients suffering from radiotherapy-induced oral mucositis by reducing pain [31,32].
In a systematic review of six RCTs, licorice-based products, including mucoadhesive patch or paste, showed a significant effect for the management of recurrent aphthous stomatitis by reducing the ulcer size, healing time, and pain severity. The observed therapeutic effect seems to be due to the anti-inflammatory properties of licorice, as well as its antimicrobial activity against some oral pathogens, such as *Porphyromonas gingivalis* and mutans Streptococci [33].

Dental and gingival disorders

Several studies have assessed the effect of licorice on dental and gingival disorders. Different licorice-based formulations such as dentifrice, mouthwash, gargle and lollipop were considered in clinical trials [34-37]. Because of anti-inflammatory and antimicrobial effects, licorice could prevent plaque formation by inhibiting bacterial colonization, in particular against mutans Streptococci. Licorice helps maintain a balanced oral pH, which is crucial since an acidic environment can lead to dental caries. Therefore, licorice can contribute to improved oral health. Additionally, due to its anti-inflammatory properties, licorice is effective in controlling gingivitis [38,39].

Dermatologic disorders

There are many clinical trials on the effect of licorice on dermatologic problems. Dermatitis is one of the skin diseases in which licorice can be helpful. There are many types of dermatitis such as atopic dermatitis, contact dermatitis, seborrheic dermatitis, and nummular dermatitis. Generally, dermatitis appears with inflammation, itching, erythema, swelling and edema. An RCT including patients with mild-to-moderate atopic dermatitis showed that licorice gel (2% concentration) can alleviate itching, edema, and erythema upon two weeks of administration [40]. An animal study in mice with atopic dermatitis suggests that glycyrrhizic acid has anti-allergic effect through modulation of tumor necrosis factor-α (TNF-α), interleukin-4 (IL-4), and interferon-γ [41]. Moreover, diammonium glycyrrhizinate, one of the components extracted from licorice, has demonstrated anti-inflammatory effects in rosacea. In a three-arm clinical trial, rosacea patients were divided into three groups and the effect of diammonium glycyrrhizinate was assessed as an adjuvant to antibiotic and isotretinoin therapy which showed a higher treatment response compared with antibiotic and isotretinoin therapy alone [42].
Psoriasis is another disease on which the effect of licorice was studied. In a pilot randomized open-label study, licorice cream as an adjuvant therapy could ameliorate complications of psoriasis, such as desquamation and erythema [43]. Also *in vitro* and *in vivo* study of liquiritin, a flavone glycoside of licorice, showed anti-inflammatory properties by affecting nuclear factor κB (NF-κB) and Activator Protein 1 (AP-1) signaling pathway [44].
Licorice has also exhibited wound healing properties. In a clinical trial on 50 patients with second degree burn wound, a hydrogel containing hydroalcoholic extract of licorice improved the healing process via decreasing redness, inflammation, pain, and burning zone compared with the placebo control [44,45].
Licorice is one of the most well-studies plants regarding its effects on hyperpigmentation and melasma. Glabridin, one of the licorice flavonoids, can inhibit UVB-induced hyperpigmentation and is up to 16 time more effective than hydroquinone in skin lightening. Liquiritin also possess depigmenting features via dispersing melanin, reducing UVB-induced erythema and anti-inflammatory properties [46]. In a clinical study in healthy Asian female with Fitzpatrick III-IV skin type, three concentrations of licorice topical cream (10, 20, and 40%) were applied for 4 weeks. It was observed that 10% concentration had the best skin brightening effect [47].

Respiratory disorders

Allergic rhinitis, mostly characterized with with congestion or runny nose, irritation in nose and/or throat, itching specially in eyes, and sneezing, is a seasonal condition which usually occurs in spring and autumn.

In a clinical trial, effectiveness of licorice extract nasal irrigation was compared with corticosteroid nasal irrigation and saline nasal irrigation. The results showed better effectiveness of licorice irrigation than corticosteroid and saline in improvement of nasal pruritus, sneezing, nasal congestion, runny nose, post nasal discharge, and olfactory disturbance [48].

Considering the beneficial effect of licorice on respiratory system, there was an interest to evaluate the effect of this plant on COVID-19. Licorice was one of the ingredients of polyherbal traditional formulas assessed in RCTs during COVID-19 pandemic. In an RCT, oral consumption of licorice extract with the dose of 760 mg three times a day for one week could reduce C-reactive protein (CRP) and alanine aminotransferase (ALT) levels; however, no clinical superiority was observed compared with the control group [49]. In another randomized, placebo-controlled clinical trial glycyrrhizin and enoxolone (derivative of glycyrrhizin) in nebulizing form decreased IL-17A expression. This result shows the preventive effect of licorice on extreme immune response in COVID-19, possibly through anti-inflammatory, immunomodulatory and antiviral properties [50]. Also, a licorice-based polyherbal syrup showed adjuvant effects as an additive therapy to the standard treatment of hospitalized COVID-19 patients via improvement of O_2 saturation and reducing hospital stay [51]. Additionally, a double-blinded, placebo-controlled RCT studied the effect of licorice extract pastilles on chronic cough with unknown origin and the results showed that licorice pastilles has beneficial effect on treatment of chronic cough [52].

A common complaint of patients after endotracheal intubation is post-operative sore throat. For the relief of this irritating feeling, a clinical trial was designed and participants who were smokers undergoing general anesthesia and endotracheal intubation received either licorice lozenges as the intervention or sugar candy as the control. A better improvement of sore throat was observed in the intervention group compared with the control [53]. Another clinical trial also demonstrated the therapeutic effects of licorice extract gargle to decrease the severity and incidence of post-operative sore throat [54]. A systematic review and meta-analysis of five clinical trials suggested preoperative use of topical licorice products to be significantly effective for the management of post-operative sore throat [55].

Gastrointestinal disorders

Functional dyspepsia is a common gastrointestinal disorder accompanied with epigastric pain, early satiety, and annoying feeling of postprandial fullness. According to a randomized, double-blind, placebo-controlled RCT, *G. glabra* extract with a daily dose of 150 mg for a period of 30 days significantly improved symptoms of dyspepsia compared to placebo and had beneficial effects on the quality of life [56]. Also, studies showed that adding licorice to triple clarithromycin-based therapy of dyspepsia, or enrichment of dietary milk with this plant extract helps to eradicate *Helicobacter pylori* in patients with this infection [57,58]. Furthermore, two clinical studies showed that replacement of bismuth derivatives with licorice products can improve *H. pylori* eradication in amoxicillin-based therapy of peptic ulcer disease [59,60].

Ulcerative colitis is another prevalent GI problem with a prevalence of 35-100 cases per 100,000 people. Diarrhea, fever, abdominal cramp, weight loss and blood in stool are the common symptoms of ulcerative colitis. A systematic review with meta-analysis and network pharmacology has investigated preclinical studies of licorice in ulcerative colitis and the results confirm that licorice extract is strongly efficient in treatment of this disease; however, clinical evidence is still lacking in this case [61].

Liver disorders

Non-alcoholic fatty liver disease (NAFLD) is the most common chronic liver disorder, accompanied with dyslipidemia, abdominal obesity, and glycemic abnormalities which results in steatohepatitis, liver fibrosis, and, in the worst situation, cirrhosis [62]. NAFLD may manifest with symptoms such as nausea, loss of appetite, itchy skin, edema of legs, fatigue, easy bruising or bleeding.

In a double-blind RCT, females with NAFLD who received 1,000 mg/day licorice root extract for 12 weeks had improvement in ALT, malondialdehyde serum levels, ultrasonographic findings of liver steatosis, insulin level and insulin resistance in comparison to the placebo group [63]. In another RCT on NAFLD patients, a decrease in ALT level and the aspartate aminotransferase (AST) levels were observed with consumption of capsules containing 2 g of licorice aqueous extract [64]. Hepatoprotective effect of licorice was also observed in alcoholic beverage consumers in a 12-day study. Licorice could prevent the elevation of ALT, AST and gamma-glutamyl transferase (GGT) in the group who received a glycyrrhizin preparation along with an alcoholic beverage in comparison to the control group who consumed alcoholic beverages alone [65].

Compound glycyrrhizin injection is an injectable dosage form made from glycyrrhizin which is assessed in icteric hepatitis in several clinical trials. A systematic review and meta-analysis on six RCTs showed that compound glycyrrhizin injection can significantly reduce total bilirubin, ALT and AST levels in children with acute icteric hepatitis; however, further high-quality studies are needed to confirm the efficacy and safety of this preparation in these patients [66].

Cardiovascular disorders

Glabridin, an isoflavone of licorice, has antioxidant effect on low-density lipoprotein cholesterol (LDL) oxidation so it can help to prevent atherosclerosis, cardiovascular diseases, inflammation, oxidative stress, diabetes and other disorders caused by oxidized-LDL [67].

In a clinical study, Zhigancao decoction (roasted licorice decoction) administered to 68 hemodialysis patients for 4 weeks and the electrocardiogram of individuals were recorded to check the alteration of QT dispersion and QTc dispersion. Results of this study showed that Zhigancao decoction reduced the prolongation of QT dispersion and QTc dispersion after hemodialysis without any adverse reactions [68].

Neuropsychological disorders

Parkinson's disease is a neurological disorder caused due to the loss of dopaminergic neurons which dramatically affects patients' quality of life and is known with symptoms such as tremor, loss of motility control, unintended movements, and muscle stiffness. A randomized double blind clinical trial investigated the effect of licorice as an adjuvant therapy in patients suffering from Parkinson's disease. Six months administration of licorice syrup could significantly improve tremor, daily activity, and rigidity compared with the control group who received the standard treatment alone [69].

Schizophrenia is a chronic mental disorder accompanied with psychosis, hallucinations, and delusions. It affects a person's ability to think clearly, manage emotions, and interact with others. One of the side effects of antipsychotic medicines prescribed for these patients is hyperprolactinemia due to dopamine blockade in hypothalamus. An RCT explored the effects of adjuvant therapy of a peony-licorice decoction to antipsychotic therapy of ninety-nine schizophrenic women for 16 weeks. Compared with the control group, antipsychotic-related hyperprolactinemia and unintended movement symptoms were significantly improved. These studies suggest more investigation on relationship between licorice and dopaminergic pathways [70].

Obstetrics and gynecologic disorders

Hot flashes are a significant challenge of postmenopausal period of a woman's life. Hormone replacement therapy (HRT) is a standard treatment to help women to get through this period more easily. In a clinical study on postmenopausal women, licorice was compared with HRT during three months of treatment. There was no significant difference in reducing hot flashes number and duration between licorice and HRT; however, HRT was more effective in reducing severity of hot flashes in comparison to licorice [71].

Polycystic ovary syndrome (PCOS) is another common gynecological disorder which affects women's fertility. Spironolactone is one of the popular conventional medicines used for the management of PCOS; though, the diuretic side effects of this medicine is a matter of concern for the patients. In a controlled clinical trial in 32 patients with PCOS, spironolactone was administered alone in the control group, and in combination with a daily dose of 3,5 g of licorice (equal to 265 mg of glycyrrhetinic acid) in the intervention group for a period of 60 days. The antagonistic effect of spironolactone on mineralocorticoid and androgen receptors combined with agonistic effect of licorice on mineralocorticoid receptors could moderately inhibit the side effects of spironolactone such as hypotension and metrorrhagia in the combination therapy [72]. Also, according to experimental researches, anti-inflammatory properties of licorice could improve immunological and histological alterations related to PCOS and ovarian cyst reduction, as well as an enhanced fertility [73,74].

Weight control

A systematic review and meta-analysis of 15 RCTs showed that licorice has a significant effect on the reduction of body weight and body mass index [75]. Most of these trials investigated the flavonoid oil of licorice with a dose range of 300-900 mg/day for a mean period of two months. Thus, this preparation of licorice seems to be effective for weight management in obesity [76].

Safety concerns

In spite of all beneficial effects of licorice, chronic intake of glycyrrhizic acid can cause elevated blood pressure and reduction in blood potassium. This side effect is due to the inhibition of 11-β-hydroxysteroid dehydrogenase enzyme type 2 (HSD-2) by glycyrrhizin and its derivatives. HSD-2 is responsible for the transformation of cortisol to inactive cortisone. By inhibition of this enzyme, an excessive amount of cortisol will be accumulated in the body which causes hypernatremia, hypokalemia, fluid retention, and subsequently, hypertension due to pseudo-hyperaldosteronism [77]. Therefore, suppression in renin and aldosterone secretion and increase in blood pressure is a result of long-term licorice consumption. There are case reports of patients diagnosed with hypertension and edema who had a history of intaking high amounts of licorice-based products [78,79]. Patients with cardiovascular disease must be aware of the cardiovascular side effects of licorice and therefore, warnings should be inserted on the licorice products [75,80, 81]. Licorice species are also inhibitors of cytochrome P450 isoforms including CYP 1A2 and CYP 3A4 which are responsible for the metabolism

of numerous conventional drugs and consequently, can cause drug interactions with the medicines which are the substrates of these enzymes [82]. Additionally, there are studies reporting the synergistic effects of licorice with anticoagulant and antiplatelet drugs and thus, patients under therapy with such medicines should take licorice products with caution [83].

Conclusions and future perspective

Current study provided an overview of the traditional uses of licorice in four traditional medicines, as well as a summary of the clinical evidence on the therapeutic activity of this plant. Comparison of the traditional uses with the modern evidence shows that several traditional medicinal properties of licorice are supported by clinical data.

Both in traditional systems of medicine and modern phytotherapy, licorice is considered a valuable medicinal plant for the management of respiratory and gastrointestinal problems.

In this paper, authors have tried to put their focus on clinical evidence in order to provide a collection of studies useful in clinical practice; however, it is worth mentioning that numerous pre-clinical studies are also available on licorice, as well as its purified secondary metabolites, discussing the pharmacological activities of these compounds and the underlying cellular and sub-cellular mechanisms. Additionally, several therapeutic applications are considered for licorice in traditional systems of medicine such as in headache, urogenital problems, and andrological disorders which are not yet investigated in clinical trials and can be the topic of future studies.

Another important application of licorice is in food industry, where it is known as a natural sweetener in sugar-free candies and sweets. Glycyrrhizin is about 50 times sweeter than sugar [84]; however, it does not affect blood glucose level. In spite of the fact that licorice can be used as a sugar replacement, especially in products for diabetic patients, it should be considered that licorice-containing products cannot be taken uncontrolled because of the possibility of pseudohyperaldosteronism. There are case reports on patients admitting to hospital with pseudohyperaldosteronism due to high intake of licorice candies [85]. Therefore, food products containing licorice should mention the recommended daily intake of the product considering the amount of licorice (or to be precise, glycyrrhizin/ glycyrrhizic acid) on the label to prevent possible overdose of glycyrrhizic acid and related health conditions.

Overall, licorice, either individually or in combination with other medicinal plants, is one of the most popular ingredients of traditional and herbal medicines which is helpful for the management of various health issues; though, considering its possible adverse effects, the long-term use of the high doses should only be considered under supervision of healthcare providers. Future studies are also recommended to further clarify the health benefits of this medicinal plant and its active components in human.

Conflicts of Interests

None.

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