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Liquorice: The Sweetener with Medicinal Properties

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Abstract: The incorporation of liquorice (*Glycyrrhiza glabra*) in foods not only introduces its distinctive sweetness but also highlights its extensive historical use in medicine, showcasing its versatility in enhancing flavours while resonating its therapeutic heritage in foods. With a rich background in traditional healing practices, liquorice stands as a botanical treasure, boasting an impressive array of medicinal properties. Beyond its medicinal recognition, liquorice serves as a natural sweetener, gaining popularity for seamlessly blending into various food products, imparting a unique and delightful flavour profile. This review discuss the dual role of liquorice as both a medicinal plant and a crucial sweetening agent in foods, elucidating its enhancement of taste while satisfying the contemporary consumer desire for reduced sugar content in food products.

Keywords: bioactive compounds, foods, glycyrrhizin, liquorice, medicinal properties, natural sweetener.

Introduction

Liquorice (*Glycyrrhiza glabra*) has a long history of usage in traditional medicine, treatment options and as a sweetening and flavouring ingredient in foods. *G. glabra* contains numerous potent phytochemicals, making it a pivotal plant in the realms of medicine, nutrition and economics (Al-Sudani et al., 2021). Liquorice consumption predates the Greek and roman civilizations (Isbrucker and Burdock, 2006).

The name “liquorice” is an abomination of the Greek word *glykyrrhiza*,which means “sweet root” and is formed from the Greek words *glukos* - sweet and *riza* - root (Olukoga and Donaldson, 1998; Quirós-Sauceda et al., 2016), which was finally Latinized to *liquiritia* and then became liquorice (Isbrucker and Burdock, 2006).

The roots and rhizomes of *G. glabra* (*Glycyrrhiza*) are widely used in herbal medicine due to their emollient, anti-inflamatory, antiviral, antiallergic, antioxidant, gastroprotective and anticancer properties (Mukhopadhyay and Panja, 2008). Around the globe, liquorice root also finds extensive use as a natural sweetener and as a flavour enhancer in numerous applications (Kitagawa, 2002; Pandey and Ayangla, 2018). *G. glabra* is usually grown in Europe, henceforth referred to as European liquorice (Rizzato et al., 2017).

The Scythians started growing the liquorice plant around the 3rd century and passed their knowledge to the Greeks. The Greeks found various uses for the plant, especially in medicine and described the Scythian liquorice as good for dry cough, asthma and all pectoral diseases. Early physicians, following Hippocrates`s practices, recommended liquorice due to its ability to prevent thirst in cases of dropsy, making it likely the only sweet substance known for this beneficial effect. The Romans also aknowledged this particular characteristic of the compound. Consequently,soldiers were provided with liquorice root to chew, using it as a way to satisfy their thirst during extensive marches (Olukoga and Donaldson, 1998).

Taxonomy and Morphology of Liquorice

Liquorice is among the members of the *Fabaceae* family, spread across the expanse from East Asia to Europe, showing remarkable adaptability in arid regions and growing even in environments with limited water availability (Ishimi et al., 2019; Khaitov et al., 2021). *Glycyrrhiza glabra* is a perennial plant or low shurb that grows upright, reaching heights of approximately 2 meters (Öztürk et al., 2017). It`s predominantly found in subtropical areas, favoring fertile soil (Dastagir and Rizvi, 2005), growing in the wild and also being deliberately cultivated (Fenwick et al., 1990). Its stems are either unbranched or branched at the base, with ridges noticeable along the stems, particularly above. The plant is smooth or slightly hairy and it`s covered with small, shiny, sticky glands across its entire surface. Stipules, thin and brownish, measure about 2 mm and are shaped like slender cones, falling off early. The leaves are compound with a main stem, measuring 10-25 cm in length. The petiole ranges from 1.5 to 3 cm and both the petiole and the central axis are somewhat ridged, often covered in fine hairs, especially on the lower side and densely covered in small glands. The leaflets ;come in 4 to 8 pairs, varying in shape from lance-shaped to elliptical, ovate or oblong, measuring approximately 20-40 (-55) by 5-18 (-25) mm. They are smooth-edged, pointed or slightly indented at the top, with dense glandular spots on their lower surface. Hairs are present along the midrib on the underside and sporadically on the surface, while the upper surface is smooth and lacs glands. The stalks attaching the leaflets to the main stem are around 2 mm long and commonly covered in fine hairs. The inflorescense is either stretched out and loosely spaced or shorter and denser, typically not surpassing the length of the leaf it emerges from, sometimes notably longer. The flowers have very short stems, the main stems of the inflorescense measure 1.5 to 3 cm and are glandular and slightly covered in short hairs (Figure 1). The accompanying small leaf-like structures, about 1 mm in size, are shaped like narrow lances, brownish and thin and they drop off early (Öztürk et al., 2017).

Glycyrrhiza glabra – A Medicinal Plant

Glycyrrhiza glabra stands as one of the most favoured medicinal plant and is recognized as a traditional herbal remedies since ancient era (Altay et al., 2016).

Medicinal applications involve utilizing the roots (Figure 2) and rhizomes through various forms such as powder, teas, tonics, extracts, tinctures and decoctions (Sharma and Agrawal, 2013).

Figure 1. Liquorice plant
(Source: adapted after Bahmani et al., 2015)

Figure 2. Liquorice root
(Source: adapted after Abraham and Florentine, 2021)

Öztürk et al., (2017) noticed that numerous experimental, pharmacological and clinical investigastions indicate that liquorice exhibits a wide range of properties including antimicrobial, antibacterial, antiviral, antifungal, liver-protective, antioxidant, ulcer-preventive, hemorrhoid-reducing, blood sugar-lowering, diuretic-reducing, kidney-protective, cancer-fighting, mutation-inhibiting, cell-toxicity-reducing, anti-inflamatory and blood stopper activity. Research indicates that liquorice root extract offers advantages in treating a wide array of conditions including eye ailments, throat infections, peptic ulcers, arthritis, liver and joint disorders, weakened immunity (Gupta et al., 2008), coughs, cancer, diabetes, tuberculosis, hormonal issues, respiratory problems, kidney ailments, bronchitis asthma, skin conditions like psoriasis and eczema, hemorroids, epilepsy, chronic hepatitis, heart diseases (Gaitry Chopra et al., 2013) and oral health issues (Öztürk et al., 2017). Chakravarthi et al., (2012) discovered that liquorice also finds application in handling conditions like impaired learning, dementia, Alzheimer's disease and various other neurodegenerative disorders.

Several constituents have been identified in *Glycyrrhiza glabra* roots, notably a water-soluble, biologically active compounds constituting 40-50% of the total dry material weight. These compounds compromises triterpene saponins, flavonoids, polysaccharides, pectins, simple sugars, amino acids, mineral salts, asparagines, bitters, essential oils, fats, estrogen, gums, mucilage (found in the rhizome), proteins, resins, starches (about 30%), sterols, volatile oils, tannins, glycosides and various other substances (Sharma and Agrawal, 2013). Glycyrrhizin (Figure 3), is a triterpenoid, a low caloric compound and is responsible for the sweet flavour of liquorice root (Sarabi-Aghdam et al., 2021). Liu et al. (2007) showed the significance of glycyrrhizin as the primary active component, holding substantial importance in both pharmaceutical and commercial value. This compound consists of a blend of potassium-calcium-magnesium salts of glycyrrhizic acid, ranging between 2-25%. Glycyrrhizic acid, among natural saponin, is a molecule composed of a hydrophilic portion containing two glucuronic acid molecules and a hydrophobic fragment known as glycyrrhetic acid (Obolentseva et al., 1999). The yellow color present in liquorice is a result of the flavonoids found in the plant, encompassing liquiritin, isliquiritin and additional compounds (Sharma and Agrawal, 2013).

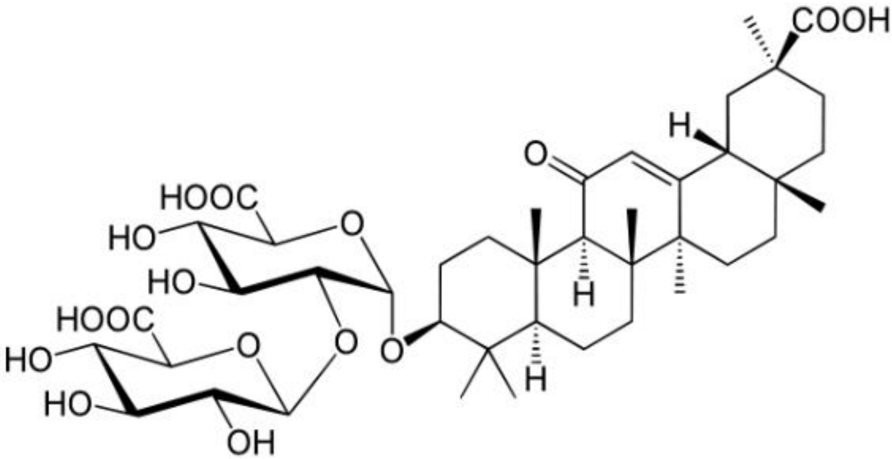

Figure 3. *Glycyrrhizin*
(Source: Han et al., 2014)

Phytochemical components found in Liquorice

Flavonoids – Over 300 flavonoids have been identified within *glycyrrhiza* species and they are responsible for its yellow color. Several flavonoids have been detected in liquorice roots, includin liquiritin, liquiritigenin, rhamnoliquiritin, liquiritin apioside, glabranin, glabrol, licoflavanone, isoliquiritigenin, neoisoliquiritin, licuraside, licochalcone A and B, licoricidin, 7-methylicoricidin, hispaglabridin A and B, licoflavone A and B, licoflavanol, glycyrrhizaglabrin, licoisoflavanone, glabroisoflavanone, glabrone, licoricone and gancaonin (Öztürk et al., 2017).

Saponins – *Glycyrrhiza* roots contain triterpenoid saponins, notably glycyrrhizin and glycyrrhizic acid, which serve as the primary characteristic components responsible for the sweet flavour in liquorice. The principal triterpenoid saponin found in the liquorice root is glycyrrhizic acid, which serves as the primary sweetening agent in this plant, nearly 50 times sweeter than sugar (Nomura et al., 2002). Additionally, other triterpenes have been identified, including liquiritic acid, glycyrretol, glabrolide, isoglaborlide and licorice acid (Isbrucker and Burdock, 2006; Öztürk et al., 2017).

Phenolic compounds – The primary phenolic compounds comprise liquiritin, isoliquiritin, liquiritin apioside and flavonoids substituted with isoprenoids, chromenes, coumarins and dihydrostilbenes (Öztürk et al., 2017). Zhang and Ye (2009) detailed a variety of phenolic compounds derived from *Glycyrrhiza* species, including glycycoumarin, glabrocoumarin, glycyrin, inflacoumarin A, licopyranocoumarin, isoglycerol, ne-glycerol, licobenzofuran, licocoumarone, glabrocoumarone, gancaonin and kanzonol.

Coumarins – Other significant components consists of coumarins like liqcoumarin, glabocoumarone A and B, herniarin, umbelliferone, glycyrin, glycocoumarin, licofuranocoumarin, licopyranocoumarin and glabrocoumarin (Öztürk et al., 2017).

Essential oils – Ali (2013) examined the essential oil makeup of *G. glabra*, revealing the presence of compounds such as α-pinene, β-pinene, octanol, ɤ-terpinene, stragole, isofenchon, β-caryophyllene, citronellyl acetate, caryophyllene oxide and geranyl hexanolate.

Glycyrrhiza glabra – A sweetener used in foods

The sweet taste of liquorice originates from glycyrrhizic acid or glycyrrhizin, a triterpenoid saponin glycoside that is 30-50 times sweeter than sucrose. Unlike the sugar substitute aspartame, glycyrrhizin retains its sweetness even after being heated. While both sugar and glycyrhizic acid offer sweetness, glycyrrhizic acid delivers a slightly delayed onset of sweetness compared to sugar. Additionally, its sweet taste lingers in the mouth for a longer period of time (Kao et al, 2014). Moreover, glycyrrhizin exhibits exceptional thermal stability, rendering it appropriate for producing heat-treated foods and it harbors compounds known for their antimicrobial properties (Al-Sudani et al., 2021).

Liquorice extract containing glycyrrhizinic acid has found its way into numerous food products and confectionery, such as chewing gum, chewing tobacco (up to 4% concentration) and ice cream (at concentrations of 0.5% or 1.5%) (Blakey, 1998; Rosseel and Schoors, 1993). Pranay et al. (2019) affirmed that glycyrrhizin contains no calories per gram and numerous manufacturers also use it as a sweetener to mask bitterness in various products.

Abd El-Lahot et al. (2017) utilized glycyrrhizin and liquorice extract from *G. glabra* as an alternative to sucrose in sweetening toffee and cake recipes. During the sensory evaluation, the toffee made by substituting sugar with glycyrrhizin at a 50:50 ratio received the highest scores across all sensory quality aspects. Conversely, when 25% of the glucose syrup was replaced by liquorice extract, the resulting toffee exhibited superior scores in sweetness, flavour, overall acceptability and lacked bitterness compared to those sweetened with a higher concentration of liquorice extract as a replacement for glucose syrop. Toffees made exclusively with 100% liquorice extract received lower average ratings for colour, sweetness, texture and overall accepatbility compared to other samples. In contrast, the flavour and texture ratings of toffees prepared using glycyrrhizin were notably higher than those made from any other blends. This difference might be attributed to the potential synergistic effect of glycyrrhizin acting as a sweetening agent. The toffee made using liquorice extract indicated that elevating the amount of extract (beyond 50%) reduced colour ratings. Meanwhile, increasing the proportion of replacers with glycyrrhizin or liquorice extract notably heightened bitterness score (Abd El-Lahot et al., 2017).

Abd El-Lahot et al. (2017) also studied the physicochemical and organoleptic characteristics of cakes by substituting sugar with glycyrrhizin at levels of 25% and 50%, alongside a control sample. The cake recipe was created using the following ingredients: flour, sugar, milk, fres whole eggs, butter, baking powder and vanilla. A noticeable reduction in cake volume was observed as the level of glycyrrhizin increased. Specific volume stands as a crucial factor, reflecting cake density and quality, particularly influencing acceptance, appearance, crumb texture and grain. In cakes containing glycyrrhizin, the specific volumes were higher compared to the control sample, suggesting a greater amount of trapped air within the cake. This increase in gas retention and expansion might contribute to the elevated specific volume (Gómez et al., 2008). As the amount of glycyrrhizin increased, the values for crumb colour decreased, signifying a darker, less red and less yellow crumb achieved through glycyrrhizin substitution. It was noticed that cakes baked using glycyrrhizin appeared darker compared to control samples. No differences were observed in the deformation of hardness across all treatments when compared to the control cakes. However, both hardness and total work cycle values decreased in cakes containing glycyrrhizin in contrast to the control sample. The substitution of sucrose with glycyrrhizin at 25% level had no impact on the cake`s acceptability when assessed for attributes like colour, taste, flavour, texture and overall acceptability. Nevertheless, increasing the glycyrrhizin ratio beyond 25% had an adverse effect on the sensory qualities of the tested cakes (Abd El-Lahot et al., 2017).

The Abd El-Lahot et al. (2017) study`s findings indicated that toffee, with sugar substituted by 50% glycyrrhizin (750 mg/100 g) and toffee prepared using 25% liquorice extract (1.37 mg/100 g) as a replacement for glucose syrop, achieved the highest ratings in terms of sweetness, flavour and overall approval. Additionally, cakes sweetened with 250 mg of glycyrrhizin as a sugar substitute showed no considerable impact on their sensory properties.

Conclusions

The integration of liquorice, a versatile medicinal plant and sweetening agent, holds promise to the growing demand for sugar reduction in various food products. Its multifaceted nature not only offers sweetness but also potentially addresses health concerns, presenting a valuable option in the quest for reduced sugar consumption within the food industry and among consumers.

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