Economic importance of licorice

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Abstract Licorice is the root and stolon of the Glycyrrhiza plant, which belongs to the family Leguminosae. The licorice plant is an important medicinal herb, and the constituent—glycyrrhizin—is widely used as a natural sweetener and also as a pharmaceutical agent because of its anti-inflammatory and hepatoprotective properties. Licorice is also an indispensable ingredient of traditional Japanese Kampo medicines. Furthermore, licorice extracts are used as cosmetics, food additives, tobacco flavors, and confectionery foods. In this article, we review the importance of licorice and its related products.

Key words: Glycyrrhiza, glycyrrhizin, Licorice, sweetener.

Licorice is the root and stolon of the Glycyrrhiza plant, which belongs to the family Leguminosae. This plant has been recognized worldwide as an important medicinal herb since ancient times (Nienan 1959, Gibson 1978, Shibata 2000). The value of the licorice trade in 2007 was estimated at 42 million US$ (Parker 2007). The name Glycyrrhiza originates from the Greek words “glykos rhiza,” which mean “sweet root.” The major component in the roots and stolons of Glycyrrhiza plants that imparts a sweet flavor—glycyrrhizin—is an oleanane-type triterpene saponin. Licorice is the most common ingredient of traditional Japanese Kampo medicines. Moreover, glycyrrhizin is used as a natural sweetener and also as a pharmaceutical agent because of its anti-inflammatory and hepatoprotective properties (Shibata 2000). The chemical constituents of licorice have been extensively studied (Nomura and Fukai 1998). Glycyrrhizin-producing Glycyrrhiza species Glycyrrhiza species are perennial plants belonging to the family Leguminosae. The following 3 Glycyrrhiza species are the major glycyrrhizin-producing species in the world: G. glabra L., G. uralensis Fisch., and G. inflata Batal. (Hayashi et al. 2000, Shibata 2000). G. glabra is found in Spain, Italy, Turkey, Iraq, Iran, Central Asia, and the northwestern part of China. This species is

Glycyrrhizin—a sweet-tasting triterpene saponin

Glycyrrhizin, a sweet-tasting triterpene saponin isolated from the Glycyrrhiza plant, is a conjugate of 2 molecules—glucuronic acid and glycyrrhetinic acid (an oleanane-type triterpene) (Figure 1). Glycyrrhizin has a long-lasting sweetness and is approximately 200 times sweeter than sucrose (Mizutani et al. 1994). Glycyrrhizin is used as a natural sweetener as well as a pharmaceutical agent owing to its anti-inflammatory and hepatoprotective properties (Shibata 2000). In addition to glycyrrhizin, many triterpene saponins and flavonoids have been isolated from Glycyrrhiza plants. Moreover, the chemical constituents of licorice have been extensively studied (Nomura and Fukai 1998).

This article can be found at http://www.jspcmh.jp/
divided into varieties such as *G. glabra* var. *typica* (Spanish licorice) and *G. glabra* var. *glandulifera* (Russian licorice). *G. uralensis* is found in Central Asia, Mongolia, and China, while *G. inflata* is found in the Xinjiang Uygur Autonomous Region of China. Interestingly, all the 3 *Glycyrrhiza* species, i.e., *G. glabra*, *G. uralensis*, and *G. inflata*, are found in Xinjiang, China; however, this component is also partly derived from *G. uralensis*, *G. glabra*, and hybrids of the 2 species.

Japan imports large quantities of licorice derived from *G. glabra* and *G. inflata* (Xinjiang-Gancao) as raw materials for the production of glycyrrhizin, cosmetics, and food additives. On the other hand, *G. uralensis* (Tohoku-Kanzo in Japanese) and *X. glandulifera* (Seihoku-Kanzo in Japanese), which are imported from China, are mainly used in the preparation of Japanese *Kampo* medicines; these medicinal licorices are derived from *G. uralensis*.

**Trade statistics related to licorice import in Japan**

Because licorice is not produced locally in Japan, the licorice used in Japan is imported from countries such as China, Afghanistan, Turkmenistan, Uzbekistan, and Pakistan. Table 1 shows the trade statistics of licorice import in Japan in 1987 and 2007 (http://www.customs.go.jp/toukei/info/index_e.htm).

Although the total amount of licorice imported in Japan was 10,723,342 kg in 1987, it decreased to 1,377,213 kg in 2007. Currently, a major proportion of glycyrrhizin is extracted and then purified in manufacturing plants in China and other licorice-producing countries; therefore, the import of licorice for glycyrrhizin production has decreased in Japan. A proportion of the licorice imported from China is medicinal licorice, which is used in *Kampo* medicines. Medicinal licorice is more expensive than licorice used for the production of glycyrrhizin and other licorice products; the latter is imported from other licorice-producing countries such as Afghanistan and Australia. The fact that 144,710 kg of licorice was imported from Australia in 2007 is remarkable. This licorice is currently being cultivated on a farm owned by a Japanese glycyrrhizin-manufacturing company, namely, Maruzen Pharmaceuticals Co. Ltd., and it is used for the production of glycyrrhizin and other licorice products.

**Applications of licorice and its derivatives**

*Use in the preparation of Kampo medicines*

The licorice root (*Glycyrrhiza radix*) is an indispensable ingredient of traditional *Kampo* medicines in Japan. Of the 210 *Kampo* prescriptions approved by the Ministry of Health, Labour and Welfare of Japan, 150 (71%) contain licorice. Although *G. uralensis* and *G. glabra* (but not *G. inflata*) are both listed in the Japanese Pharmacopeia, most of the medicinal licorices used in *Kampo* medicines are derived from *G. uralensis*, which is imported from China. According to the standards of the Japanese Pharmacopeia XV, medicinal licorice must be used in licorice-containing *Kampo* medicines, and the minimum content of glycyrrhizin in these medicines should be 2.5% according to the standards of the Japanese Pharmacopeia.

*Pharmaceutical preparations*

Glycyrrhizin is a prescription drug used in the treatment of liver and allergic diseases in Japan. It is manufactured as an injectable preparation (Stronger Neo-Minophagen® C) and in a tablet form (Glycyron®) by a Japanese company, namely, Minophagen Pharmaceutical Co. Ltd. (Figure 2). Stronger Neo-Minophagen® C has been available in the Japanese market for over 60 years. In addition, it is available in China, Korea, Taiwan, Indonesia, India, and Mongolia, where the

<table>
<thead>
<tr>
<th>Year</th>
<th>Country of origin</th>
<th>Quantity (kg)</th>
<th>Value (JPY1000)</th>
<th>Price (JPY/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1987</td>
<td>China</td>
<td>5,298,304</td>
<td>1,098,344</td>
<td>207</td>
</tr>
<tr>
<td></td>
<td>USSR</td>
<td>2,730,619</td>
<td>325,310</td>
<td>119</td>
</tr>
<tr>
<td></td>
<td>Afghanistan</td>
<td>2,304,547</td>
<td>215,739</td>
<td>94</td>
</tr>
<tr>
<td></td>
<td>Pakistan</td>
<td>267,700</td>
<td>21,730</td>
<td>81</td>
</tr>
<tr>
<td></td>
<td>Turkey</td>
<td>116,382</td>
<td>15,000</td>
<td>129</td>
</tr>
<tr>
<td></td>
<td>Hong Kong</td>
<td>4,023</td>
<td>1,986</td>
<td>494</td>
</tr>
<tr>
<td></td>
<td>Taiwan</td>
<td>1,767</td>
<td>734</td>
<td>415</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>10,723,342</td>
<td>1,678,843</td>
<td>157</td>
</tr>
<tr>
<td>2007</td>
<td>China</td>
<td>932,503</td>
<td>372,387</td>
<td>399</td>
</tr>
<tr>
<td></td>
<td>Afghanistan</td>
<td>300,000</td>
<td>21,887</td>
<td>73</td>
</tr>
<tr>
<td></td>
<td>Australia</td>
<td>144,710</td>
<td>12,463</td>
<td>86</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>1,377,213</td>
<td>406,737</td>
<td>295</td>
</tr>
</tbody>
</table>

*These data are based on the trade statistics of Japan published by the Ministry of Finance and the Customs of Japan (http://www.customs.go.jp/toukei/info/index_e.htm).*

Glycyrrhizin, glycyrrhetinic acid, and licorice extracts are used in various over-the-counter drugs, including antiallergic and anti-inflammatory drugs. In addition, in England, the glycyrrhetinic acid derivative glycyrrhetinic acid 3-β-O-hemisuccinate (carbenoxolone) is a prescription drug used in the treatment of peptic ulcers.

**Cosmetics**

Licorice extracts and many glycyrrhizin derivatives are widely used in the preparation of cosmetics in Japan. Glycyrrhizin as well as powdered Glycyrrhiza roots, Glycyrrhiza extracts, glycyrrhetic acid, stearyl glycyrrhetinate, pyridoxine glycyrrhetinate, and glycyrrhetinic acid 3-β-O-hemisuccinate (carbenoxolone) are used in cosmetics for their anti-inflammatory action. Furthermore, glabridin-containing glycyrrhiza flavonoids isolated from *G. glabra* are used in cosmetic preparations owing to their skin-whitening, anti-sensitizing, and anti-inflammatory properties (Yokota et al. 1998).

**Food additives**

Glycyrrhizin imparts a sweet taste to foods; moreover, it has salt-softening and flavor-enhancing properties and is also heat stable. Most Japanese people do not like the long-lasting sweet taste of glycyrrhizin; however, a more acceptable sweetness can be created by using a combination of glycyrrhizin and natural sugars or other sweeteners. Therefore, glycyrrhizin and licorice extracts are used as food additives in a variety of foods. Figure 3 shows examples of foods, such as snacks, instant noodles, and sauces, that contain licorice extracts. Glycyrrhizin is used in sweet foods such as sweet snacks, ice creams, and sherbets to enhance their sweetness. It is also used to reduce the saltiness of salty foods such as soy sauce, other sauces, savory snacks, Kamaboko (boiled fish paste), Tsukudani (fish boiled in soy sauce), tsukemono (Japanese pickles), and sausages in Japan.

In Japan, enzymatically modified licorice extract (α-glycosyl-glycyrrhizin) and enzymatically hydrolyzed licorice extract (glycyrrhetinic acid 3-O-glucuronide) are also used as sweeteners. The former is produced by treating the extract with cyclodextrin glycosyltransferase, and it is used as a sweetener because of it has higher solubility and better taste than the untreated licorice extract (Liu et al. 2000). The latter is obtained by enzymatic hydrolyzation of the licorice extract. The sweetness of this licorice is attributable to glycyrrhetinic acid 3-O-glucuronide (Kuramoto et al. 1994), which imparts a strong sweetness that is approximately 941 times that of sucrose (Mizutani et al. 1994).

**Flavor additives for tobacco**

Large quantities of licorice extracts are used in the tobacco industry. Licorice not only imparts a sweet taste but also an aroma to tobacco, which makes it mild (Nieman 1959). It also prevents the desiccation of tobacco. The licorice extracts used in the tobacco industry are supplied by an American company, namely, MAFCO (http://www.jerindo.com/mafco.php#). Table 2 shows the trade statistics related to licorice extracts in Japan in 1987 and 2007. Japan imported large quantities (848,704 kg in 1987 and 458,179 kg in 2007) of licorice extracts for tobacco production from the USA, and the value for the same in 2007 was more than 500 million Yen.

**Confectionery**

Licorice extracts were first used for flavoring confectionery products in England during the 18th century; it was blended with sugar, flour, and other ingredients to make Pontefract cakes (Neiman 1959). Nowadays, licorice confectionery is widely available in western countries, and large quantities of licorice are used in the confectionery industry (Figure 4). However, since the Japanese do not like the long-lasting sweet taste

<table>
<thead>
<tr>
<th>Year</th>
<th>Country of origin</th>
<th>Quantity (kg)</th>
<th>Value (JPY1000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1987</td>
<td>USA</td>
<td>848,704</td>
<td>785,777</td>
</tr>
<tr>
<td></td>
<td>China</td>
<td>41,137</td>
<td>12,146</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>889,841</td>
<td>797,923</td>
</tr>
<tr>
<td>2007</td>
<td>USA</td>
<td>458,179</td>
<td>511,803</td>
</tr>
<tr>
<td></td>
<td>Israel</td>
<td>76,800</td>
<td>65,481</td>
</tr>
<tr>
<td></td>
<td>China</td>
<td>70,115</td>
<td>77,212</td>
</tr>
<tr>
<td></td>
<td>India</td>
<td>110</td>
<td>7,137</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>605,204</td>
<td>661,633</td>
</tr>
</tbody>
</table>

*These data are based on the trade statistics of Japan published by the Ministry of Finance and the Customs of Japan (http://www.customs.go.jp/toukei/info/index_e.htm).
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of glycyrrhizin, licorice confectionery is not popular in Japan.

Licorice resources and future prospects

At present, since commercial production of glycyrrhizin by plant cell culture is difficult (Hayashi et al. 1988, Henry et al. 1991), glycyrrhizin is obtained from the licorice of wild or cultivated Glycyrrhiza plants. The recent over-utilization of wild Glycyrrhiza plants has resulted in a reduction in the natural reserves and desertification of the habitats of these plants, especially in China. Thus, in 2000, the Chinese government enforced restrictions on the collection of wild licorice, leading to a shortage of licorice in the market (Yamamoto et al. 2005). Glycyrrhiza cultivation has been undertaken to compensate for the reduction in the natural reserves of Glycyrrhiza plants; however, the glycyrrhizin content of the licorice obtained from these plants is often low. Recently, researchers were successful in producing 4-year-old adventitious roots with glycyrrhizin levels that conformed to the Japanese Pharmacopeia standard (not less than 2.5%) (Yamamoto et al. 2003, Yamamoto and Tani 2006). Phylogenetic relationship of six Glycyrrhiza species based on rbcL sequences and chemical constituents. Biol Pharm Bull 23: 602–606


Parker PM (2007) The World market for licorice roots. ICON Group Ltd., USA


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Parker PM (2007) The World market for licorice roots. ICON Group Ltd., USA


Figure 4. Licorice confectionery