Prunus salicina

Scientific Name

***Prunus salicina* Lindley**

Synonyms

Prunus thibetica Franch., *Prunus triflora* Roxb.

Family

Rosaceae

Common/English Names

Asian Plum, Californian Plum, Chinese Plum, Japanese Blood Plum, Japanese Box Plum, Japanese Plum, Nai Plum, Ussurian Plum, Willow-Leaf Cherry.

Vernacular Names

Brazil: Ameixa-Japonêsa (Portuguese);
Chinese: Dong Bel Li, Li, Li Zi, Ri Ben Li,;
Czech: Slivoň Vrbová;
Danish: Japansk Blomme, Pilebladet Blomme;
Dutch: Japanse Pruim, Kaspruim;
Eastonian: Pajulehine Ploomipuu;
Finnish: Japaninluumu
French: Prune Japonaise, Prune Sanguine Du Japon, Prune Japonaise À Chair Rouge, Prunier Du Japon, Prunier Japonais;
German: Chinesische Pflaume, Chinesischer Pflaumenbaum, Dreibluetige Pflaume, Japanische Pflaume, Japanischer Pflaumenbaum;
Hungarian: Japán Szilva, Kínai Fűzringló, Kínai Szilva;
Icelandic: Víðiplóma;
Italian: Ciliegia Del Giappone, Prugna Del Giappone, Susino Giapponese;
Japanese: Batankyō, Sumomo;
Korean: Churinam, Jadu, jadunamu;
Laotian: 'Mân 'Luang, Tsi Keu;
Malay: Ijas Jepang;
Portuguese: Ameixeira-Japonêsa;
Russian: Sliva Iaponskaia;
Slovašcina: Kitajskojaponska Sliva;
Spanish: Cirolero Japonés, Ciruela Japonesa, Ciruelo Japonés;
Swedish: Kinesiskt Plommon;
Vietnamese: Prun.

Origin/Distribution

Prunus salicina is native to China and is commonly cultivated in China, Korea and Japan. Improved cultivars were developed mainly in Japan and were distributed and cultivated in other temperate localities including in Australia and USA.

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Agroecology

In its native range, the tree is found in sparse forests, forest margins, thickets, scrub, along trails in mountains, stream sides in valleys from 200 to 2,600m altitude. It is widely cultivated in China – Anhui, Fujian, Gansu, Guangdong, Guangxi, Guizhou, Hebei, Heilongjiang, Henan, Hubei, Hunan, Jiangsu, Jiangxi, Jilin, Liaoning, Ningxia, Shaanxi, Shandong, Shanxi, Sichuan, Yunnan, Zhejiang and Taiwan.

Prunus salicina has winter chill requirement to overcome bud dormancy. Chill requirement for three groups of cultivars were 700–900 chill units (Rumayor-Rodriguez 1995) whereas low chill cultivars have lower chill requirements of 200–350 chill units (Rouse and Sherman 1997). Japanese plum thrives in areas with warm summers and mild springs. Late spring frosts may kill flowers and summer rains may lead to diseases. Humid conditions during the ripening of the fruit are undesirable because they favour the development of brown rot.

Edible Plant Parts and Uses

The ripe fruit is excellent when eaten fresh. The fruit is also used in canning and made into jam, jellies, juice wine and liquor. In China, a liquor is made from the fruits. In Japan, half-ripe fruits are used as a flavouring in a liqueur called *sumomo shu.* Fruits are also dried, preserved or candied, flavoured with sugar, salt, and liquorice.

Botany

A deciduous, small-medium-sized, branched, unarmed tree, 9–12 m high. Branches and branchlets are reddish-brown glabrous (Plates 3, 4, 5) or pubescent and winter buds are purplish-red usually glabrous. Stipules are linear, margin glandular, apex acuminate. Leaves are alternate, on 1–2 cm long petiole with 2 nectaries at the apex. Lamina is oblong-obovate, narrowly elliptic, or rarely oblong-ovate, 6–8(−12) × 3−5 cm, dark green and glossy above, apex acute to shortly with 6–7 pairs of lateral veins. caudate, base cuneate, margin doubly crenate (Plates 3, 4, 5). Flowers usually 3 in a fascicle, 1.5–2.2 cm in diameter on 1–1.5 cm pedicels (Plates 1 and 2). Hypanthium campanulate; sepals, 5 oblong-ovate, outside glabrous, margin loosely serrate, apex acute to obtuse ,imbricate; petals 5, white, oblong-obovate, base cuneate; ovary glabrous, superior, 1-ovuled; style elongated; stigma disc-shaped, stamens numerous 20–30. Fruit a drupe yellow, red, or purple, globose (Plate 3, 4, 5, 6, 7), ovoid, or conical, 3.5–5 cm in diameter to 7 cm in diameter in horticultural forms, glaucous; mesocarp fleshy, reddish (Plate 7) or yellow-pink; endocarp ovoid to oblong, rugose.

Nutritive/Medicinal Properties

Japanese plum was reported to have the following mean nutritional composition range based on 6 cultivars of *Prunus salicina* (Lozano et al. 2009): moisture 80.65–89.40%, energy 183–331 kJ/100 g, protein 0.38–0.96%, ash 0.19–0.53%, carbohydrate 10.04–17.9%, dietary fibre 0.84–1.50%, glucose 4.41–10.27%, fructose 1.82–4.79%, sucrose 0.65–4.34%. Total soluble solids (TSS) ranged from 13.4 to 17.8 °Brix, TSS/total acidity 9.26–20.86, acidity (% malic acid) 0.85–1.85%, pH 3.14–3.42. Total phenolic content 95.54–202.46 mg/100 g, anthocyanin 10.93–28.93 mg/100 g and total antioxidant activity 258.6–946.52 mg Trolox/100 g. Of the cultivars, 'Black Amber' had the highest phenolic and anthocyanin contents and the greatest total antioxidant activity. Of the volatile compounds, those present in the greatest proportion are the esters 4-hexen-1-ol acetate and hexyl acetate, guanidine, and 3-hexen-1-ol. 'Fortune; stood out as the richest cultivar with esters. Other compounds identified in the volatile fraction include 2-butanone + heaxan, 2 methyl-3-buten-2-ol, ethyl acetate, trichloromethne, 3-methylbutanol, hexanal, ethyl butanoate, butyl acetate, (Z)-3-hexen-1-ol, (E) -2-hexen-1-ol, furan tetrahydro-2,4-dimethyl-trans-, *m*-xylene, styrene, nonane, isopropylben-

Plate 1 Fascicle of Japanese blood plum blooms

Plate 2 Close-up of Japanese blood plum flower

zene, α-methylstyrene, cyclotetrasiloxane octamethyl-, ethyl hexanoate, decane, (E)-2-hexen-1-ol-acetate, 2-ethyl-1-hexanol, 2-hydroxy-1-phenyl-ethanone, α α dimethyl benzenemethanol, N,4-dimethyl-benzeamine, 4-hexenyl propanoatr, butyl hexanoate, (E)-2-hexenyl butanoate, ethyl octanoate, ciclodecanol, 4-hexenyl butanoate, 4-hexenyl hexanoate, hexyl hexanoate, butyl caprylate, 2-hexenyl hexanoate, tetradecane and butylated hydroxytoluene. The C6 compounds presented aromatic notes of freshly cut grass and green apples. The esters had pleasant fruity aromas. In terms of their volatile fraction, Japanese plums were relatively poor in

Plate 3 Immature Japanese blood plums and leaves

Plate 4 Prolific bearing Japanese blood plum tree

Plate 5 Near ripe Japanese blood plum with wax bloom

volatile compounds in comparison with other stone fruits. However, there were significant differences between the cultivars studied, with 'Fortune' emerging as the richest in volatile compounds and especially in esters.

Plate 6 Harvested ripe Japanese blood plums

Plate 7 Blood–red flesh of ripe Japanese blood plum

P. salicina cultivars differed in their relative contens of fructose, glucose, sorbitol, and sucrose and of organic acids (malic, shikimic and succinic, citric, tartaric and fumaric acid) (Singh and Singh 2008). Fructose was the major sugar followed by glucose, sorbitol and sucrose. Sugar concentration in Japanese plum varied with cultivar, maturity and harvest season. Late-maturing plum cultivars accumulated more sugar. The changes in individual sugars during ripening of these cultivars were not significant suggesting a low possibility of sugar interconversion. The percentage of sucrose to the total sugar concentration varied greatly among these cultivars. In 'Blackamber', sucrose contributed only 8% whereas its contribution was 17% and 18% in 'Amber Jewel' and 'Angeleno', respectively. Malic acid accounted for the major share of the total organic acids accounting for 80–89% of the total acids concentration followed by succinic, shikimic (both 10–18%), and citric acids. There were also traces of tartaric and fumaric acids. Robertson et al. (1992) found that the average firmness of the maturity Japanese plums was 25 N. Mean chemical compositions for all cultivars were as follows: soluble solids – 127 g/kg; acidity – 174.4 g/kg; soluble solids to acidity ratio – 7.4, and total sugar content – 96 g/kg.

P. salicina aside from being a nutritious fruit with antioxidant polyphenolic compounds also has some pharmacological activities which include antioxidant, anticancer, immunostimulatory and glucosyltransferase inhibition activities.

Anticancer Activity

Studies showed that an acetone extract of immature plums possessed cytotoxic effects, which were related to the activity of the total polyphenols in the fruits (Yu et al. 2007). Apoptosis in MDA-MB-231 cells mediated by the immature plums was associated with an increase in Bax levels and a reduction in Bcl-2 levels and the cleavage of caspase 3, caspase 7, caspase 9 and poly-(ADP-ribose) polymerase. These results indicated that immature fruit of *P. salicina* Lindl. cv. Soldam can be regarded as a safe and promising new dietary source for decreasing the risk of developing breast cancer. Studies also suggested that immature plum extracts possessed chemopreventive efficacy and may counteract toxic effects of carcinogens, such as B(α)P (Kim et al. 2008). Male ICR mice were pretreated with immature plum extracts (2.5 or 5 g/kg bw/day, for 5 days, i.p.) before treatment with B(α)P(0.5 mg/kg bw, i.p., single dose). The activities of serum aminotransferase, cytochrome P450 (CYPs) and the hepatic content of lipid peroxide were increased on B(α) P-treatment group and control, but those levels were significantly decreased by the pretreatment of immature plum extracts. The pretreatment of immature plum extracts inhibited the induction of CYP1A1 expression. The activities of glutathione peroxidase, superoxide dismutase and catalase were decreased by the pretreatment of immature plum extracts more than with B(α)P alone. Whereas, the hepatic content of glutathione and glutathione S-transferase activity depleted by B(α)P was significantly increased.

In subsequent studies, the scientists reported that in comparison with other cancer cells, the growth inhibition exerted by immature plum extracts was greatest in HepG2 (Yu et al. 2009a). Apoptosis in HepG2 cells mediated by immature plums was associated with "death receptor signaling." The total yield of identified polyphenols in immature plum extract was 10 g/kg dry weight. The major components, (−)-epicatechin and (−)-gallocatechin gallate, were 34.7% and 28.6% of total polyphenols, respectively. (+)-Catechin, (−)-epicatechin gallate, and (−)-catechin gallate were also found. On the basis of these results, the immature plum (*P. salicina* Lindl. cv. Soldam) and its active compound, (−)-epicatechin, were suggested to be a natural resource for developing novel therapeutic agents for cancer prevention and treatment.

Immature plum extract (IPE) appeared to have a strong inhibitory effect on the PMA (phorbol 12-myristate 13-acetate)-induced matrix metallopeptidase 9 (MMP-9) secretion through suppression of the transcriptional activity of the MMP-9 gene independently of the TIMP gene in HepG2 cells (Yu et al. 2009b). The results indicated that IPE suppressed both AP-1- and NF-κB-mediated MMP-9 gene transcriptional activity through inhibiting the nuclear translocations of AP-1 and NF-κB. IPE elicited a decrease in the migration potential of HepG2 cells in-vitro, and this suggested that the migration inhibition correlated well with its inhibition of MMP-9 expression. MMP-9 is known to play a role in tumour-associated tissue remodeling.

Immunostimulatory Activity

Methanol extract of plum fruit exhibited immunostimulatory effects (Lee et al. 2009). The crude methanol extract stimulated spleen lymphocyte proliferation and NO production by cultured macrophages, and inhibited the viability of tumour cells, significantly greater than media controls.

Glucosyltransferase Inhibition Activity

Among the extracts from 420 kinds of herbs tested in Korea, *Prunus salicina*, showed the highest glucosyltransferase inhibition activity (Won et al. 2007) The active principle was purified and designated GTI-0163. GTI-0163 was revealed to be an oleic acid-based unsaturated fatty acid. Among the unsaturated fatty acids, oleic acid showed a significantly higher GTase inhibitory activity than the saturated fatty acids or the ester form of oleic acid. Glucosyltransferase is an enzyme which transfers residues of glucose to acceptor molecules.

Traditional Medicinal Uses

The fruit is stomachic. It is said to be good for allaying thirst and is given in the treatment of arthritis.

Other Uses

The plant is often grown as an ornamental. Green and dark grey-green dyes can be obtained from the leaves and fruit respectively.

Comments

The species has been divided into two botanically recognised lower taxa:

Prunus salicina var. *pubipes* (Koehne) L. H. Bailey and *Prunus salicina* var. *salicina.*

Selected References

Bown D (1995) Encyclopaedia of herbs and their uses. Dorling Kindersley, London, 424 pp

Chopra RN, Nayar SL, Chopra IC (1986) Glossary of Indian medicinal plants. (Including the supplement). Council Scientific Industrial Research, New Delhi, 330 pp

Facciola S (1990) Cornucopia. A source book of edible plants. Kampong Publ, Vista, 677 pp

Grae I (1974) Nature's colors – dyes from plants. MacMillan Publishing Co, New York

Gu C, Bartholomew B (2003) *Prunus* Linnaeus. In: Wu ZY, Raven PH, Hong DY (eds) Flora of China, vol 9, Pittosporaceae through Connaraceae. Science Press/Missouri Botanical Garden Press, Beijing/St. Louis

Kim HJ, Yu MH, Lee IS (2008) Inhibitory effects of methanol extract of plum (*Prunus salicina* L., cv. 'Soldam') fruits against benzo(alpha)pyrene-induced toxicity in mice. Food Chem Toxicol 46(11):3407–3413

Lee SH, Lillehoj HS, Cho SM, Chun HK, Park HJ, Lim CI, Lillehoj EP (2009) Immunostimulatory effects of oriental plum (*Prunus salicina* Lindl.). Comp Immunol Microbiol Infect Dis 32(5):407–417

Lozano M, Vidal-Aragón MC, Hernández MT, Ayuso MC, Bernalte MJ, García J, Velardo B (2009) Physicochemical and nutritional properties and volatile constituents of six Japanese plum (*Prunus salicina* Lindl.) cultivars. Eur Food Res Technol 228(3):403–410

Robertson JA, Meredith FI, Senter SD (1992) Physical, chemical and sensory characteristics of Japanese-type plums grown in Georgia and Alabama. J Sci Food Agric 60:339–347

Rouse RE, Sherman WB (1997) Plums for Southwest Florida. Proc Fla State Hort Soc 110:184–185

Rumayor-Rodriguez A (1995) Multiple regression models for the analysis of potential cultivation areas for Japanese plums. HortScience 30(3):605–610

Singh SP, Singh Z (2008) Major flavor components in some commercial cultivars of Japanese plum. J Am Pomol Soc 62(4):185–190

Won SR, Hong MJ, Kim YM, Li CY, Kim JW, Rhee HI (2007) Oleic acid: an efficient inhibitor of glucosyltransferase. FEBS Lett 581(25):4999–5002

Yu MH, Im HG, Kim HI, Lee IS (2009a) Induction of apoptosis by immature plum in human hepatocellular carcinoma. J Med Food 12(3):518–527

Yu MH, Im HG, Lee SG, Kim DI, Seo HJ, Lee IS (2009b) Inhibitory effect of immature plum on PMA-induced MMP-9 expression in human hepatocellular carcinoma. Nat Prod Res 23(8):704–718

Yu MH, Im HG, Lee SO, Sung C, Park DC, Lee IS (2007) Induction of apoptosis by immature fruits of *Prunus salicina* Lindl. cv. Soldam in MDA-MB-231 human breast cancer cells. Int J Food Sci Nutr 58(1):42–53