Prunus avium

Scientific Name

***Prunus avium* (L.) L.**

Synonyms

Cerasus avium (L.) Moench, *Cerasus avium* var. *aspleniifolia* G. Kirchn., *Cerasus dulcis* P. Gaertn., *Cerasus nigra* Miller, *Druparia avium* Clairv., *Prunus avium* var. *aspleniifolia* (G. Kirchn.) H. Jaeger, *Prunus avium* (L.) L. var. *sylvestris* Dierb., *Prunus cerasus* L. var. *avium* L. (basionym), *Prunus macrophylla* Poir.

Family

Rosaceae

Common/English Names

Bing Cherry, Bird Cherry, Crab Cherry, Gean, Mazzard, Sweet Cherry, Wild Cherry.

Vernacular Names

Arabic: Karaz Barrî, Kuryaz;
Brazil: Cereja, Cerejeira;
Bulgaria: Cheresha;
Chinese: Ou Zhou Tian Ying Tao, Tian Guo Ying Tao, Tian Ying Tao, Ye Ying Tao;
Croatian: Tresnja;
Czech: Toešeň Ptačí, Třešeň Obecná, Třešeň Ptačí;
Danish: Fugle-Kirsebær, Kirsebær, Sødkirsebær;
Dutch: Kers, Wilde Kersenboom, Zoete Kers, Zoete Kersen, Zoete Kerseboom;
Estonian: Magus Kirsipuu, Vili: Maguskirss;
Finnish: Imeläkirsikka, Kirsikka;
French: Amèrise, Cerise Douce, Cerisier Des Oiseaux, Merise, Merisier;
German: Bauernkirsche, Gemeine Vogelkirsche, Herzkirsche, Kirschbaum, Kirsche, Süßkirsche, Süßkirschenbaum, Vogel-Kirsche, Waldkirsche, Wildkirsche;
Greek: Kerasia;
Hebrew: Dudevan;
Hungarian: Cseresznye, Madárcseresznye, Vadcseresznye
Icelandic: Fuglakirsiber;
India: Gilaas (Hindu), Kerii (Urdu);
Italian: Ciliegia Dolce, Ciliegia Di Monte, Ciliegio, Ciliegio Montano, Ciliegio Selvatico, Ciliegio Visciolo, Ciregiolo;
Japanese: Kanka Outou, Outou, Sakuranbo, Seiyo-Mizakura;
Korean: Beo Ji, Beojinamu, Tanpotnamu, Yangaengdonamu, Yang Beot, Yangsalgu;
Macedonian: Creshna;
Malay: Buah Céri;
Norwegian: Morell, Søtkirsebær;
Persian: Gilas;
Polish: Czereśnia, Czereshnia Dzika, Czereshnia Ptasia, Trzeshnia Dzika;

T.K. Lim, *Edible Medicinal And Non-Medicinal Plants: Volume 4, Fruits*,
DOI 10.1007/978-94-007-4053-2_52, © Springer Science+Business Media B.V. 2012

Portuguese: Agriota,Cereja,Cerejeira, Cerejeira-Brava;
Romanian: Cireş;
Russian: Chereshnia, Vishnia Ptich'ia;
Serbian: Tresnja;
Slovenian: Čerešňa Vtáčia, Cheshnja;
Spanish: Cerasus Dulce, Cerecera, Ceresera, Cereza, Cereza Silvestre, Cerezo, Cerezo Borde, Cerezo Bravío, Cerezo De Aves, Cerezo De Monte, Cerezo Silvestre, Guereciga, Guindo Zorrero, Maroviña, Picota;
Swedish: Fågelbär, Fågelkörsbär, Körsbärsträd, Sötkörs, Sötkörsbär, Vildkörsbär;
Turkish: Kiraz, Yabani Kiraz.

Origin/Distribution

P. avium is indigenous to the area between the Black and Caspian seas of Asia Minor and spread to Europe prior to human civilization. Domestic cultivation probably began with Greeks, and later perpetuated by the Romans. Sweet cherries came to the USA with English Colonists in 1629. It is cultivated in other temperate areas in both hemispheres.

Agroecology

Sweet cherries thrive best in cool and somewhat dry temperate areas where the danger of late frost is restricted. They have a high chill requirement to break bud dormancy. Sweet cherries are adapted traditionally to high chill areas-usually from 800 to 1,700 h chilling (Richards et al. 1995). Medium chill cultivars are being used in crosses with *Prunus pleioceracus, Prunus campanulata* and other low chilling cherry species to develop low chill selections. Sweet cherries does best in full-sun and in areas where rain does not fall during harvest as rain causes fruit cracking. High humidity and rain during fruit development is also bad as they increase incidence of brown rot fruit disease. Rain and hail during ripening and harvesting season can cause yield losses up to 90% in sweet cherry cultivations (Mucha-Pelzer et al. 2006) Particularly, high yield losses after precipitation are due to the cracking and the following rotting process through bacteria and fungi. A fertile, well-drained, light sandy loams are preferred. Mulching is also important. Flooded or waterlogged soils should be avoided as it impedes growth and reduce productivity. Irrigation is required on sandy soils and during the dry seasons for optimum productivity.

Edible Plant Parts and Uses

Ripe sweet cherries are excellent when eaten fresh or lightly chilled. Cherries can be frozen, canned, dried or preserved in brine (maraschino). Canned and frozen sweet cherries are a tasty ingredients in many recipes. They're also ready to eat and delicious straight from the can or freezer. The most popular canned sweet cherries are reddish purple to deep purple Bing Cherries and golden yellow to rosy pink Royal Anne Cherries. Maraschino cherries are made mostly from sweet cherries, but a small proportion of sour cherries are brined for this purpose. Cherries with clear flesh are picked slightly early, steeped in Marasca, a liqueur distilled from the fermented juice of wild cherries. Maraschino cherries, sometimes called cocktail cherries, are sweet cherries that have been tinted red with food coloring, flavored with almond extract, sweetened with sugar and packed in a sugar syrup. maraschino cherries goes very well with ice cream sundae or a banana split. Dried cherries, a relatively new cherry product, are delicious as snacks, wonderful in salads, and increasingly popular in recipes for everything from appetizers to entrees and desserts. Sweet cherries fresh, frozen, canned or dried are used in a wide array of food, snacks and desserts. Some notable food recipes include pork with cherry salsa, cherry orange chicken, cabernet beef jubilee, cherry rice pilaf and *cherry pierogi* (dumplings). Snacks and desserts with cherries include cherry pineapple fruit salad, fresh fruit ambrosia, *cherry clafouti*, frozen cheese fruit salad, cherry pies, cherry custard pie, cherry bread pudding, cherry-banana-pecan bread, pineapple cherry upside-down cake, traditional cherry fruit cake, black forest cake,

pancakes, waffles, cherry chocolate chip muffins, pastries, cherry cookies, brownies, cherry fruit bars, cherry crunch bars, cherry oatmeal power-bars, cherry milkshakes, cherry smoothies, sherberts and cherries with ice cream.

The gum from bark wounds is aromatic and can be chewed as a substitute for chewing gum.

Botany

A medium-sized to large, deciduous, perennial tree, 5–25 m high with erect-pyramidal shaped canopy and dark brownish-black bark. Young branchlets are green becoming greyish-brown with age (Plate 1). Winter buds are ovoid-ellipsoid and glabrous. Petioles are glabrous, 2–7 cm long with two nectaries at the base, stipule are linear with serrated margins. Leaves are alternate, obovate-elliptic to elliptic-ovate, 3–13 × 2–6 cm, green and glabrous above, pale green and sparsely pubescent below, base cuneate to rounded, apex shortly acuminate, margin obtusely incised and serrted (Plates 2, 3, and 4). Flowers in 2–5 flowered umbellate inflorescence on short spurs with multiple buds at tips opening at same time as leaves. Flowers bisexual, fragrant, 1.5–3 cm across, on 2–6 cm long pedicels with distinct, glabrous, cyathiform hypanthium; sepals 5 elliptic lobes, recurved after anthesis, margin entire, apex obtuse; petals 5s white, obovate, apex

Plate 1 A heavy fruiting well-trained sweet cherry tree

Plate 2 Sweet cherries and leaves

Plate 3 Ripening sweet cherries

Plate 4 Clusters of ripening sweet cherries

Plate 5 Harvested ripe sweet cherries

emarginate; stamens numerous 30–35; style as long as stamen, ovary perigynous, superior. Fruit a fleshy drupe bright red, maroon to purplish black (Plates 2, 3, 4, and 5) sometimes golden yellow, subglobose to ovoid, 1.5–2.5 cm in diameter, mesocarp red sometimes white, succulent, juicy and fleshy enclosing a smooth, hard endocarp containing one seed.

Nutritive/Medicinal Properties

Food value of raw, sweet cherries (refuse 8% pit, pedicels) per 100 g edible portion was reported as follows (USDA 2011): water 82.25 g, energy 63 kcal (263 kJ), protein 1.06 g, total lipid (fat) 0.20 g, ash 0.48 g, carbohydrate 16.01 g; fibre (total dietary) 2.1 g, total sugars 12.82 g, sucrose 0.15 g, glucose 6.59 g, fructose 5.37 g, maltose 0.12 g, galactose 0.59 g; minerals – calcium 13 mg, iron 0.36 mg, magnesium 11 mg, phosphorus 21 mg, potassium 222 mg, sodium 0 mg, zinc 0.07 mg, copper 0.060 mg, manganese 0.070 mg, fluoride 2 μg, selenium 0 μg; vitamins – vitamin C (total ascorbic acid) 7.0 mg, thiamin 0.027 mg, riboflavin 0.033 mg, niacin 0.154 mg, pantothenic acid 0.199 mg, vitamin B-6 0.049 mg, folate (total) 4 μg, total choline 6.1 mg, vitamin A 64 IU (3 μg RAE), vitamin E (α-tocopherol) 0.07 mg, β-tocopherol 0.01 mg, γ-tocopherol 0.04 mg, vitamin K (phylloquinone) 2.1 μg, lipids – fatty acids (total saturated) 0.038 g, 14:0 (myristic acid) 0.001 g, 16:0 (palmitic acid) 0.027 g, 18:0 (stearic acid) 0.009 g; fatty acids (total monounsaturated) 0.047 g, 16:1 undifferentiated (palmitoleic acid) 0.001 g, 18:1 undifferentiated (oleic acid) 0.047 g; fatty acids (total polyunsaturated) 0.052 g, 18:2 undifferentiated (linoleic acid) 0.027 g, 18:3 0.026 g; phytosterols 12 mg, β-carotene 38 μg, lutein + zeaxanthin 85 μg; amino acids – tryptophan 0.009 g, threonine 0.022 g, isoleucine 0.020 g, leucine 0.030 g, lysine 0.032 g, methionine 0.010 g, cystine 0.010 g, phenylalanine 0.024 g, tyrosine 0.014 g, valine 0.024 g, arginine 0.018 g, histidine 0.015 g, alanine 0.026 g, aspartic acid 0.569 g, glutamic acid 0.083 g, glycine 0.023 g, proline 0.039 g and serine 0.030 g.

The major non-volatile constituents of sweet cherry cultivars varied widely among cultivars: glucose (5.2–8.8 g/100 g of fresh weight (FW)), fructose (4.4–6.4 g/100 g of FW), sorbitol and mannitol (2.2–8.0 g/100 g of FW), and malic acid (502.7–948.3 mg/100 g of FW) (Girard and Kopp 1998). Three principal components accounted for 53.3% of the total variation among 50 volatile compounds: (E)-2-Hexenol, benzaldehyde, hexanal, and (E)-2-hexenal were predominant flavor volatiles. Fruit fresh weight ranged from 8.8 to 14.5 g per fruit, soluble solids concentration (SSC) from 13.5 to 24.5 degrees Brix, and SSC/TA (titratable acidity ratio) from 18.3 to 29.0.

Studies showed that ascorbic acid, total antioxidant activity (TAA), and total phenolic compounds decreased during the early stages of sweet cherry development but exponentially increased from ripening stage 8, which coincided with the anthocyanin accumulation and fruit darkening (Serrano

et al. 2005). TAA showed positive correlations ($R^2=0.99$) with both ascorbic acid and total phenolic compounds and also with the anthocyanin concentration from stage 8. Studies showed that during fruit ripening, there were significant increases in weight, soluble solids content, fructose, total phenols, total anthocyanins and total antioxidant activity; a non-significant decrease in firmness; and significant decreases in the colour parameters of both skin and flesh and in glucose (Serradilla et al. 2011). Five anthocyanins were found, of which the most abundant was cyanidin-3-O-rutinoside; 3 hydroxycinnamic acids, of which was p-coumaroylquinic acid predominated; a flavonol (rutin); and a flavan-3-ol (epicatechin) in small amount. Because of the increased levels of bioactive compounds associated with it, ripening stage 5 was considered to represent the highest nutritional and functional quality.

Total phenolics in sweet and sour cherries per 100 g ranged from 92.1 to 146.8 and from 146.1 to 312.4 mg gallic acid equivalents, respectively (Kim et al. 2005). Total anthocyanins of sweet and sour cherries ranged from 30.2 to 76.6 and from 49.1 to 109.2 mg cyanidin 3-glucoside equivalents, respectively. Anthocyanins such as cyanidin and peonidin derivatives were dominant phenolics. Hydroxycinnamic acids consisted of neochlorogenic acid, chlorogenic acid, and p-coumaric acid derivatives. Glycosides of quercetin, kaempferol, and isorhamnetin were also found. In another study, *P. avium* fruit was found to contain 78.8 mg GAE/100 g fresh weight total phenolics, 19.6 mg CE/100 g fresh weight total flavonoids, flavonoids/phenolics ratio of 0.25 (Marinova et al. 2005). Sweet and sour cherries are rich in polyphenolic compounds particularly phenolic acids and anthocyanins; Anthocyanins contributed more to the antioxidant activity of all fruits (~90%) than flavonols, flavan-3-ols and phenolic acids (~10%) (Jakobek et al. 2009). A biphasic reaction was observed between DPPH radicals and phenols, with 'fast' and 'slow' scavenging rates which might be important in the biological activity of these cherries. Sweet cherries were found to have 2010.67 mg/kg total phenols (TP), 192.5 total anthocyanins (TA), TA/TP ratio of 0:1 and antioxidant activities in terms of DPPH 4.22 umol TE/g and, ABTS (2,2,-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid) diammonium salt) 13.62 umol TE/g (Jakobek et al. 2007). Flavonols identified in sweet cherry were quercetin (9 mg/kg), kaempferol (6 mg/kg) and myricetin (0.17 mg /kg). Among five investigated phenolic acid, only caffeic acid (1 ng/kg) and p-coumaric acid (5 mg/kg) were identified in the study.

The phenolic compounds hydroxycinnamates, anthocyanins, flavonols, and flavan-3-ols of sweet cherry cultivars Burlat, Saco, Summit, and Van were quantified and analyzed at partially ripe and ripe stages and during storage at 15 ± 5°C (room temperature) and 1–2°C (cool temperature) (Gonçalves et al. 2004). Neochlorogenic and p-coumaroylquinic acids were the main hydroxycinnamic acid derivatives, but chlorogenic acid was also identified in all cultivars. The 3-glucoside and 3-rutinoside of cyanidin were the major anthocyanins. Peonidin and pelargonidin 3-rutinosides were the minor anthocyanins, and peonidin 3-glucoside was also present in cvs. Burlat and Van. Epicatechin was the main monomeric flavan-3-ol with catechin present in smaller amounts in all cultivars. The flavonol rutin was also detected. Cultivar Saco contained the highest amounts of phenolics [227 mg/100 g of FW] and cv. Van the lowest (124 mg/100 g FW). Phenolic acid contents generally decreased with storage at 1–2°C and increased with storage at 15 ± 5°C. Anthocyanin levels increased at both storage temperatures. In cv. Van, the anthocyanins increased up to 5-fold during storage at 15 ± 5°C (from 47 to 230 mg/100 g FW). Flavonol and flavan-3-ol contents remained quite constant. The major organic acid in sweet cherry cultivars (Van, Noir de Guben, Larian and 0–900 Ziraat) was found as malic acid (8.54–10.02 g/k FW); other organic acids found were citric, shikimic and fumaric acids (Kelebek and Selli 2011). With regard to sugars, glucose was present in the highest amounts (44.71–48.31 g/kg FW). Other sugars presented included sucrose, fructose and sorbitol. A total of 11 phenolic compounds were identified and quantified in the sweet cherry cultivars, including hydroxycinnamic acids (3), anthocyanins (5), flavan-3-ols (2) and flavonol

(1) compounds. Total phenolic contents ranged from 88.72 (Van) to 239.54 (Noir de Guben) mg/100 g FW, while antioxidant activities ranged from 2.02 to 7.75 μm Trolox equivalents/g FW.

Sweet cherries contained melatonin, a free radical scavenger and modulator of the sleep-wake cycle in mammals' and serotonin the main intermediate in melatonin biosynthesis (Rodríguez 2009). The limits of detection of the proposed analytical method were 4.3 ng/ml for melatonin and 3.0 ng/ml for serotonin. The highest melatonin amounts were found in 'Burlat' sweet cherries (22.4 ng/100 g of fresh fruit), while the highest serotonin contents were found in the cultivar 'Ambrunés' (37.6 ng/100 g of fresh fruit).

Non-flavonoid (16 compounds) and flavonoid (27 compounds) polyphenols were identified in cherry heartwood used for cooperage (Sanz et al. 2010). The non-flavonoids found were lignin constituents, and include compounds such as protocatechuic acid and aldehyde, p-coumaric acid, methyl vanillate, methyl syringate, and benzoic acid, but not ellagic acid, and only a small quantity of gallic acid. In seasoned wood, the researchers found a great variety of flavonoid compounds which had not been found in oak wood for cooperage, mainly, in addition to the flavan-3-ols (+)-catechin, a B-type procyanidin dimer, and a B-type procyanidin trimer, the flavanones naringenin, isosakuranetin, and eriodictyol and the flavanonols aromadendrin and taxifolin. Seasoned and toasted cherry wood showed different ratios of flavonoid to non-flavonoid compounds, since toasting results in the degradation of flavonoids, and the formation of non-flavonoids from lignin degradation. In contrast, cherry wood had no hydrolyzable tannins, which were very important in oak wood used in cooperage.

Cherries, and in particular sweet cherries, are a nutritionally dense food rich in anthocyanins, quercetin, hydroxycinnamates, potassium, fibre, vitamin C, carotenoids, and melatonin (McCune et al. 2011). UV concentration, degree of ripeness, postharvest storage conditions, and processing, each could significantly alter the amounts of nutrients and bioactive components. These constituent nutrients and bioactive food components support the potential preventive health benefits of cherry intake in relation to cancer, cardiovascular disease, diabetes, inflammatory diseases, and Alzheimer's disease (Ferretti et al. 2010; McCune et al. 2011). In-vitro and in-vivo animal studies had shown that cherries exhibited relatively high antioxidant activity, low glycemic response, COX 1 and 2 enzyme inhibition, and other anti-carcinogenic effects. However, well-designed cherry feeding studies are needed to further substantiate any health benefits in humans (McCune et al. 2011). Other pharmacological properties of sweet cherries reported include antimicrobial, neuroprotective, photoprotective, diuretic, anti-genotoxic activities.

Antioxidant Activity

Harvesting sweet cherry 4 days later than the commercial harvest date coupled with storage at 2°C for 16 days and a further period of 2 days at 20°C gave the highest antioxidant capacity for total antioxidant activity (TAA), in the hydrophilic (H-TAA) or lipophilic (L-TAA) fractions although important differences existed among cultivars (Serrano et al. 2009).

The amount of total phenolics varied between 617 and 4,350 mg/kg in fresh berries (blackberries, red raspberries, blueberries, sweet cherries and strawberries), as gallic acid equivalents (GAE) (Heinonen et al. 1998). In the copper-catalyzed in-vitro human low-density lipoprotein oxidation assay at 10 μM gallic acid equivalents (GAE), berry extracts inhibited hexanal formation in the order: blackberries > red raspberries > sweet cherries > blueberries > strawberries. In the copper-catalyzed in-vitro lecithin liposome oxidation assay, the extracts inhibited hexanal formation in the order: sweet cherries > blueberries > red raspberries > blackberries > strawberries. Red raspberries were more efficient than blueberries in inhibiting hydroperoxide formation in lecithin liposomes. HPLC analyses showed high anthocyanin content in blackberries, hydroxycinnamic acid in blueberries and sweet cherries, flavonol in blueberries, and flavan-3-ol in red raspberries. The antioxidant activity for LDL was associated directly with anthocyanins and indirectly with

flavonols, and for liposome it correlated with the hydroxycinnamate content. Berries thus contribute a significant source of phenolic antioxidants that may have potential health effects.

The antioxidant activity of anthocyanins from cherries was comparable to the commercial antioxidants, tert-butylhydroquinone, butylated hydroxytoluene and butylated hydroxyanisole, and superior to vitamin E, at a test concentration of 125 μg/ml (Seeram et al. 2001). The presence and levels of cyanidin-3-glucosylrutinoside 1 and cyanidin-3-rutinoside 2 were determined in both fruits. The yields of pure anthocyanins 1 and 2 in 100 g Balaton and Montmorency tart cherries, sweet cherries and raspberries were 21, 16.5; 11, 5; 4.95, 21; and 4.65, 13.5 mg, respectively. Total sugars (glucose, fructose, sucrose and sorbitol) in 13 sweet cherries cultivars ranged from 125 to 265 g/kg fresh weight (FW) and total organic acids (malic, citric, shikimic and fumaric) ranged from 3.67 to 8.66 g/kg FW (Usenik et al. 2008). Total phenolic content ranged from 44.3 to 87.9 mg gallic acid equivalents/100 g FW and antioxidant activity ranged from 8.0 to 17.2 mg ascorbic acid equivalent antioxidant capacity mg/100 g FW. The correlation of antioxidant activity with total phenolics content and content of anthocyanins was cultivar dependent.

Total phenolics in the tart and sweet cherry juices and wines were 56.7–86.8 mg of gallic acid equivalents (GAE)/l and 79.4–149 mg GAE/l, respectively (Yoo et al. 2010). Total anthocyanins in the cherry juices and wines were 7.9–50.1 mg of cyanidin 3-glucoside equivalents (CGE)/l and 29.6–63.4 mg CGE/l, respectively. Both cherry juices and wines exhibited protective effects against oxidative stress induced by H_2O_2 on V79-4 lung fibroblast cells and also enhanced the activities of antioxidative enzymes, such as superoxide dismutase and catalase, in a dose-dependent manner. The protection of V79-4 cells from oxidative stress by phenolics was mainly attributable to anthocyanins. The positive correlation between the protective effects against oxidative stress in V79-4 cells and the antioxidant enzyme activities was stronger for cyanidin 3-glucoside than for cyanidin 3-rutinoside.

Cherries contain bioactive anthocyanins that are reported to possess antioxidant, anticancer, antiinflammatory, antidiabetic and antiobese properties. Mulabagal et al. (2009) reported that red sweet cherries contained cyanidin-3-O-rutinoside as major anthocyanin (>95%). The sweet cherry cultivar "Kordia" (aka "Attika") showed the highest cyanidin-3-O-rutinoside content, 185 mg/100 g fresh weight. The red sweet cherries "Regina" and "Skeena" were similar to "Kordia", yielding cyanidin-3-O-rutinoside at 159 and 134 mg/100 g fresh weight, respectively. The yields of cyanidin-3-O-glucosylrutinoside and cyanidin-3-O-rutinoside were 57 and 19 mg/100 g fresh weight in the sour cherry cultivars "Balaton" and 21 and 6.2 mg/100 g fresh weight in "Montmorency", respectively, in addition to minor quantities of cyanidin-3-O-glucoside. The water extracts of "Kordia", "Regina", "Glacier" and "Skeena" sweet cherries gave 89, 80, 80 and 70% of lipid peroxidation (LPO) inhibition, whereas extracts of "Balaton" and "Montmorency" were in the range of 38–58% at 250 μg/ml. Methanol and ethyl acetate extracts of the yellow sweet cherry "Rainier" containing β-carotene, ursolic, coumaric, ferulic and cafeic acids inhibited LPO by 78 and 79%, respectively, at 250 μg/ml. In the cyclooxygenase (COX) enzyme inhibitory assay, the red sweet cherry water extracts inhibited the enzymes by 80–95% at 250 μg/ml. However, the methanol and ethyl acetate extracts of "Rainier" and "Gold" were the most active against COX-1 and -2 enzymes. Water extracts of "Balaton" and "Montmorency" inhibited COX-1 and -2 enzymes by 84, and 91 and 77, and 87%, respectively, at 250 μg/ml. Cyclooxygenase (COX) is an enzyme that is responsible for the formation of prostanoids. The three main groups of prostanoids: prostaglandins, prostacyclins, and thromboxanes are involved in the inflammatory response.

Anticancer Activity

The sweet cherry (*P. avium*) extract obtained with a mixture of CO_2: ethanol (90:10, v/v) exhibited the highest antioxidant activity (181.4 μmol

TEAC/g) and was the most effective in inhibiting the growth of human colon cancer cells (ED_{50} = 0.20 mg/ml) (Serra et al. 2010). Perillyl alcohol was found to be one of the major compounds responsible for antiproliferative properties of cherry extracts and polyphenols, in particular sakuranetin and sakuranin, appeared to be the major contributors of the antioxidant capacity. Saco sweet cherry and two exotic cultivars (Ulster and Lapin) proved to have higher contents of phenolic compounds, highest antioxidant activity and were the most effective in inhibiting human cancer cells derived from colon (HT29) and stomach (MKN45) (Serra et al. 2010). Correlation of the data obtained showed that anthocyanins were the major contributors to the antioxidant capacity and antiproliferative effect of cherries. In addition, hydroxycinnamic acids (neochlorogenic acid, chlorogenic acid and p-coumaroylquinic acid), flavan-3-ols (catechin and epicatechin) and flavonols (rutin and quercetin-3-glucoside) also played important roles in protection against oxidative stress.

Antiinflammatory Activity

The cyanidin in cherries could protect against the paws swelling in Freund's adjuvant-induced arthritis (AIA) rats, and alleviate the inflammatory reaction in the joint (He et al. 2005, 2006). anthocyanins at 20 and 10 mg/kg had less effect on the inflammatory factors and antioxidative capacity of Freund's adjuvant-induced arthritis than the high dose of 40 mg/kg. Anthocyanins at 40 mg/kg significantly decreased the levels of TNFα in serum and prostaglandin E2 in paws, simultaneously improving the anti-oxidative status of AIA. At the high dosage total antioxidative capacity (T-AOC) was potentiated, the activity of glutathione (GSH), superoxide dismutase (SOD) increased and the level of malonaldehyde (MDA) in serum decreased. The results suggested that the Anthocyanins from cherries have potential antiinflammatory and anti-oxidative effects and could be one of the potential candidates for the alleviation of arthritis. The studies supported earlier findings by Blazso and Gabor (1994) that the extract of its fruit stalks may reduce inflammations. Cherry fruit stalk extracts had also been reported to exert a positive effect on the cardiovascular system and smooth muscles (Hetenyi and Valyi-Nagy 1969a, b).

The physiologic effects of cherry consumption with respect measured plasma urate, antioxidant and inflammatory markers was studied in 10 healthy women (22–40 years old) (Jacob et al. 2003). Five hours post-consumption, plasma urate declined to 183 μmole/l from a pre-consumption level of 214 μmole/l. Urinary urate increased significantly post-consumption, with peak excretion of 350 μmol/mmol creatinine 3 hours post-consumption compared with 202 at baseline. Plasma C-reactive protein (CRP) and nitric oxide (NO) concentrations had decreased marginally 3 hours post-consumption, whereas plasma albumin and tumour necrosis factor-α were unchanged. The vitamin C content of the cherries was solely as dehydroascorbic acid, but post-consumption increases in plasma ascorbic acid indicated that dehydroascorbic acid in fruits was bioavailable as vitamin C. The decrease in plasma urate after cherry consumption supported the reputed anti-gout efficacy of cherries. Cherries and cherry juice have been used since the 1950s by sufferers of gout and arthritis to ease their symptoms. The trend toward decreased inflammatory indices (CRP and NO) indicated that compounds in cherries may inhibit inflammatory pathways.

The physiologic effects of bing cherry consumption was studied in 18 healthy men and women. Cherry consumption did not affect the plasma concentrations of total-, HDL-, LDL-, and VLDL- cholesterol, triglycerides, subfractions of HDL, LDL, VLDL, and their particle sizes and numbers (Kelley et al. 2006). It also did not affect fasting blood glucose or insulin concentrations or a number of other chemical and hematological variables. However, results suggested a selective modulatory effect of sweet cherries on CRP, NO, and RANTES (regulated upon activation, normal T-cell expressed, and secreted). Such antiinflammatory effects may be beneficial for the management and prevention of inflammatory pathways in cardiovascular diseases.

Cherry extracts had also been reported to inhibit the action of cyclooxygenase-1 (COX-1) and COX-2 enzymes, important components of the inflammatory process and the sensation of pain (Seeram et al. 2001; McCune et al. 2011). Anthocyanins from raspberries *Rubus idaeus* and sweet cherries *Prunus avium* demonstrated 45% and 47% cyclooxygenase-I and cyclooxygenase-II inhibitory activities, respectively, when assayed at 125 μg/ml (Seeram et al. 2001). The cyclooxygenase inhibitory activities of anthocyanins from these fruits were comparable to those of ibuprofen and naproxen (antiinflammatory agents) at 10 μM concentrations. Anthocyanins cyanidin-3-glucosylrutinoside and cyanidin-3-rutinoside were present in both cherries and raspberry.

Antimicrobial Activity

Sweet cherry fruit extracts exhibited high antimicrobial and antioxidant activities (Ahn et al. 2009). The hot-water fruit extract contained about 40% sugars, and the solvent fraction yields for hexane, ethyl acetate (EA), butanol, and water residue were 0.01%, 3.45%, 16.30%, and 80.24%, respectively (Ahn et al. 2009). Contents of total polyphenol and total flavonoid of the fractions were 1.24–5.24%, and 0–3.76%, respectively. Among the fractions, the ethyl acetate fraction showed the highest total polyphenol and total flavonoid concentrations. The ethyl acetate fraction and butanol fraction exhibited strong antibacterial activity against *Listeria monocytogenes, Staphylococcus aureus*, and *Salmonella typhimurium* with minimal inhibitory concentration (MIC) of 0.5–1.0 mg/ml. But the extract and fractions tested were not active to *Pseudomonas aeruginosa*. The hexane fraction showed anti-Candida activity with 0.5–1.0 mg/ml of MIC. The fraction also showed strong activity against different multi-antibiotics resistant strains such as *C. albicans* CCARM 14,020. Antioxidative activity assay showed that ethyl acetate fraction had a strong DPPH scavenging activity and a reducing power. The IC_{50} values of vitamin E and ethyl acetate fraction were 15.5 and 195.5 μg/ml, respectively.

Sweet cherry wood contain the following flavonoid compounds: δ-catechin, naringenin, pruning, aromadendrin (traces), eriodictyol, taxifolin, chrysin, aequinoctin, genistein, prunetin (Hasegawa 1957) and the heartwood has eight known flavonoid aglycones, namely pinocembrin, pinostrobin, dihydrowogonin, naringenin, sakuranetin, aromadendrin-7-methylether, chrysin and tectochrysin (Vinciguerra et al. 2003). Some of the flavanones and flavones from the heartwood and resin of *Prunus avium* exhibited human cytochrome P450 1A1, 3A4 and 19 (aromatase) inhibition, and for antifungal activity against a panel of pathogenic fungi (McNulty et al. 2009). Two flavonol glycosides, quercetin 3-rutinosyl-4′-glucoside and kaempferol 3-rutinosyl-4′-glucoside, and a flavanone glucoside, dihydrowogonin 7-glucoside, were identified in sweet cherry leaves (Mo et al. 1995). Flavonoids are known to have a potent positive role in human health.

Antigenotoxic Activity

Among the fruit juices, sweet cherry juice exhibited the highest inhibitory effect on 2-amino-3-methylimidazo[4,5-f]quinoline (IQ) genotoxicity (IC_{50} = 0.17%), followed by juices from kiwi fruit, plum and blueberry (IC_{50} = 0.48–0.71%) (Platt et al. 2010). The juices from watermelon, blackberry, strawberry, black currant, and Red delicious apple showed moderate suppression, whereas sour cherry, grapefruit, red currant, and pineapple juices were only weakly active. In most cases, fruits and vegetables inhibited 2-amino-1-methyl-6-phenylimidazo[4,5-b]pyridine (PhIP) genotoxicity less strongly than IQ genotoxicity.

Diuretic Activity

Powdered cherry fruit stalks had diuretic activity (Hooman et al. 2009). After administration of cherry stalk, the mean of urine calcium, sodium, chloride, and urine volume increased, but the amount of urine potassium and urine osmolality did not change. No adverse reaction was observed. Powdered cherry stalk increased mild urine

volume confirming thus the claimed diuretic effect of the plant. Administration of cherry stalk caused urinary sodium and chloride rising less than loop diuretics but higher than the others. Because of rising calcium excretion, it should be used with cautioun in people with urolithiasis.

Photoprotective Activity

Oral administration of 450 mg/kg body weight per day of cherry fruit pulp methanol extract to Swiss Albino mice for 15 consecutive days before exposure to 10 Gy of γ-radiation was found to afford maximum protection in terms of body weight and survivability of the mice in comparison to other doses (Sisodia et al. 2009). Oral administration of a *P. avium* fruit extract significant halted significant elevation of lipid peroxidation and depletion in glutathione and protein levels in blood serum and spleen in irradiated mice (Sisodia et al. 2011). γ radiation-induced deficit in blood sugar, cholesterol, and hematological constituents could also be modulated by supplementation of cherry fruit extract before and after irradiation. This photoprotective effect was postulated to the possible synergistic action of various antioxidants, minerals, vitamins, etc., present in the cherry fruit.

Neuroprotective Activity

Cherry phenolics protected neuronal cells (PC 12) from cell-damaging oxidative stress in a dose-dependent manner mainly due to anthocyanins (Kim et al. 2005). The results showed cherries to be rich in phenolics, especially in anthocyanins, with a strong anti-neurodegenerative activity in diseases like dementia and that they could serve as a good source of biofunctional phytochemicals in our diet.

Bioavailability Studies

The bioavailability of phenolic compounds from frozen sweet cherries was investigated by a digestion process involving pepsin-HCl digestion (to simulate gastric digestion) and pancreatin digestion with bile salts (to simulate small intestine conditions) and dialyzed to assess serum- and colon-available fractions (Fazzari et al. 2008). Following pancreatic digestion and dialysis, the total phenolics in the IN (serum-available) fraction was about 26–30% and the OUT (colon-available) fraction was about 77–101%. The anthocyanin content in the IN fraction was 15–21%, and in the OUT fraction, it was 52–67%. Immature cherries had higher % total phenolics in the IN fraction than mature or over-mature cherries. However, immature cherries had the lowest concentrations of these compounds, making the actual bioavailable amounts of these compounds lower than for mature and over-mature fruit.

Traditional Medicinal Uses

In traditional medicine, the fruit stalks are astringent, antitussive, diuretic and tonic. The fruit stalks (cherry tails) are sold by herbal druggists in Iran and are used as decoction for relief of renal stones, oedema and hypertension (Kirtikar and Basu 2001). The decoction is also used in the treatment of cystitis, oedema, bronchial complaints, looseness of the bowels and anaemia. An aromatic resin from the trunk has been used as an inhalant in the treatment of persistent coughs. *P. avium* like all *Prunus* species contain the exceedingly poisonous compounds amygdalin and prunasin in the seeds which break down in water to form hydrocyanic acid (cyanide or prussic acid). In small amounts, they have been reported to stimulate respiration and improve digestion.

Other Uses

The leaves yield a green dye and the fruit a dark grey/dark green dye. The hard reddish cherry wood is valued for turnery, cooperage and used for making fine furniture, cabinets, musical instruments, and carvings.

Comments

Cherry trees are readily propagated from hardwood cuttings or graftings.

Selected References

Ahn L, Seon MI, Ryu H-Y, Kang D-K, Jung I-C, Sohn HY (2009) Antimicrobial and antioxidant activity of the fruit of *Prunus avium*. Han'gug Mi'saengmul Saengmyeong Gong Haghoeji 37(4):371–376

Blazso G, Gabor M (1994) Anti-inflammatory effects of cherry (*Prunus avium* L.) stalk extract. Pharmazie 49:540–541

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

Chiej R (1984) The Macdonald encyclopaedia of medicinal plants. Macdonald & Co., London, 447pp

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

Faust M, Suranyi D (1997) Origin and dissemination of cherry. Hort Rev 19:263–317

Fazzari M, Fukumoto L, Mazza G, Livrea MA, Tesoriere L, Marco LD (2008) In vitro bioavailability of phenolic compounds from five cultivars of frozen sweet cherries (*Prunus avium* L.). J Agric Food Chem 56(10):3561–3568

Ferretti G, Bacchetti T, Belleggia A, Neri D (2010) Cherry antioxidants: from farm to table. Molecules 15(10):6993–7005

Girard B, Kopp TG (1998) Physicochemical characteristics of selected sweet cherry cultivars. J Agric Food Chem 46(2):471–476

Gonçalves B, Landbo AK, Knudsen D, Silva AP, Moutinho-Pereira J, Rosa E, Meyer AS (2004) Effect of ripeness and postharvest storage on the phenolic profiles of Cherries (*Prunus avium* L.). J Agric Food Chem 52(3):523–530

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

Grieve M (1971) A modern herbal, 2 vols. Penguin/Dover publications, New York, 919pp

Hasegawa M (1957) Flavonoids of various *Prunus* species. VI. The flavonoids in the wood of *Prunus aequinoctialis*, *P. nipponica*, *P. Maximowiczii* and *P. avium*. J Am Chem Soc 79(7):1738–1740

He YH, Xiao C, Wang YS, Zhao LH, Zhao HY, Tong Y, Zhou J, Jia HW, Lu C, Li XM, Lu AP (2005) Antioxidant and anti-inflammatory effects of cyanidin from cherries on rat adjuvant-induced arthritis. Zhongguo Zhong Yao Za Zhi 30(20):1602–1605 (In Chinese)

He YH, Zhou J, Wang YS, Xiao C, Tong Y, Tang JC, Chan AS, Lu AP (2006) Anti-inflammatory and anti-oxidative effects of cherries on Freund's adjuvant-induced arthritis in rats. Scand J Rheumatol 35(5):356–358

Heinonen IM, Meyer AS, Frankel EN (1998) Antioxidant activity of berry phenolics on human low-density lipoprotein and liposome oxidation. J Agric Food Chem 46(10):4107–4112

Hetenyi E, Valyi-Nagy T (1969a) Pharmacology of cherry (*Prunus avium*) stalk extract. I. Effect on smooth muscle. Acta Physiol Acad Sci Hung 35:183–188

Hetenyi E, Valyi-Nagy T (1969b) Pharmacology of cherry (*Prunus avium*) stalk extract. II. Cardiovascular effects. Acta Physiol Acad Sci Hung 35:189–197

Hooman N, Mojab F, Nickavar B, Pouryousefi-Kermani P (2009) Diuretic effect of powdered *Cerasus avium* (cherry) tails on healthy volunteers. Pak J Pharm Sci 22(4):381–383

Jacob RA, Spinozzi GM, Simon VA, Kelley DS, Prior RL, Hess-Pierce B, Kader AA (2003) Consumption of cherries lowers plasma urate in healthy women. J Nutr 133(6):1826–1829

Jakobek L, Šeruga M, Novak I, Medvidović-Kosanović M (2007) Flavonols, phenolic acids and antioxidant activity of some red fruits. Deutsche Lebensmittel-Rundschau 103(8):369–378

Jakobek L, Šeruga M, Šeruga B, Novak I, Medvidović-Kosanović M (2009) Phenolic compound composition and antioxidant activity of fruits of *Rubus* and *Prunus* species from Croatia. Int J Food Sci Technol 44(4):860–868

Kelebek H, Selli S (2011) Evaluation of chemical constituents and antioxidant activity of sweet cherry (*Prunus avium* L.) cultivars. Int J Food Sci Technol 46:2530–2537

Kelley DS, Rasooly R, Jacob RA, Kader AA, Mackey BE (2006) Consumption of Bing sweet cherries lowers circulating concentrations of inflammation markers in healthy men and women. J Nutr 136(4):981–986

Kim DO, Heo HJ, Kim YJ, Yang HS, Lee CY (2005) Sweet and sour cherry phenolics and their protective effects on neuronal cells. J Agric Food Chem 53(26):9921–9927

Kirtikar KR, Basu BD (2001) Indian medicinal plants, vol 4, 2nd edn. Oriental Enterpries, Uttranchal, pp 1330–1349

Marinova D, Ribarova F, Atanassova M (2005) Total phenolics and total flavonoids in Bulgarian fruits and vegetables. J Univ Chem Technol Metall 40(3):255–260

McCune LM, Kubota C, Stendell-Hollis NR, Thomson CA (2011) Cherries and health: a review. Crit Rev Food Sci Nutr 51(1):1–12

McNulty J, Nair JJ, Bollareddy E, Keskar K, Thorat A, Crankshaw DJ, Holloway AC, Khan G, Wright GD, Ejim L (2009) Isolation of flavonoids from the heartwood and resin of *Prunus avium* and some preliminary biological investigations. Phytochemistry 70(17–18):2040–2046

Mo YY, Geibel M, Bonsall RF, Gross DC (1995) Analysis of sweet cherry (*Prunus avium* L.) leaves for plant signal molecules that activate the syrB gene required for synthesis of the phytotoxin, syringomycin, by *Pseudomonas syringae* pv *syringae*. Plant Physiol 107(2):603–612

Mucha-Pelzer T, Müller S, Rohr F, Mewis I (2006) Cracking susceptibility of sweet cherries (*Prunus avium* L.) under different conditions. Commun Agric Appl Biol Sci 71(2 Pt A):215–223

Mulabagal V, Lang GA, DeWitt DL, Dalavoy SS, Nair MG (2009) Anthocyanin content, lipid peroxidation and cyclooxygenase enzyme inhibitory activities of sweet and sour cherries. J Agric Food Chem 57(4):1239–1246

Platt KL, Edenharder R, Aderhold S, Muckel E, Glatt H (2010) Fruits and vegetables protect against the genotoxicity of heterocyclic aromatic amines activated by human xenobiotic-metabolizing enzymes expressed in immortal mammalian cells. Mutat Res 703(2):90–98

Porcher MH et al (1995–2020) Searchable World Wide Web Multilingual Multiscript Plant Name Database. Published by The University of Melbourne, Australia. http://www.plantnames.unimelb.edu.au/Sorting/Frontpage.html

Richards GD, Kantharajah K, Sherman WB, Porter GW (1995) Progress with low-chill sweet cherry breeding in Australia and USA. Acta Hort (ISHS) 403:179–181

Rodríguez AB (2009) Detection and quantification of melatonin and serotonin in eight Sweet Cherry cultivars (*Prunus avium* L.). Eur Food Res Technol 229(2):223–229

Sanz M, Cadahía E, Esteruelas E, Muñoz AM, Fernández De Simón B, Hernández T, Estrella I (2010) Phenolic compounds in cherry (*Prunus avium*) heartwood with a view to their use in cooperage. J Agric Food Chem 58(8):4907–4914

Seeram NP, Momin RA, Nair MG, Bourquin LD (2001) Cyclooxygenase inhibitory and antioxidant cyanidin glycosides in cherries and berries. Phytomedicine 8(5):362–369

Serra AT, Seabra IJ, Braga MEM, Bronze MR, de Sousa HC, Duarte CMM (2010) Processing cherries (*Prunus avium*) using supercritical fluid technology. Part 1: Recovery of extract fractions rich in bioactive compounds. J Supercrit Fluid 55(1):184–191

Serradilla MJ, Lozano M, Bernalte MJ, Ayuso MC, López-Corrales M, González-Gómez D (2011) Physicochemical and bioactive properties evolution during ripening of 'Ambrunés' sweet cherry cultivar. LWT Food Sci Technol 44(1):199–205

Serrano M, Díaz-Mula HM, Zapata PJ, Castillo S, Guillén F, Martínez-Romero D, Valverde JM, Valero D (2009) Maturity stage at harvest determines the fruit quality and antioxidant potential after storage of sweet cherry cultivars. J Agric Food Chem 57(8): 3240–3246

Serrano M, Guillén F, Martínez-Romero D, Castillo S, Valero D (2005) Chemical constituents and antioxidant activity of sweet cherry at different ripening stages. J Agric Food Chem 53(7):2741–2745

Sisodia R, Sharma K, Singh S (2009) Acute toxicity effects of *Prunus avium* fruit extract and selection of optimum dose against radiation exposure. J Environ Pathol Toxicol Oncol 28(4):303–309

Sisodia R, Singh S, Mundotiya C, Meghnani E, Srivastava P (2011) Radioprotection of Swiss albino mice by *Prunus avium* with special reference to hematopoietic system. J Environ Pathol Toxicol Oncol 30(1):55–70

U.S. Department of Agriculture, Agricultural Research Service (2011) USDA National Nutrient Database for Standard Reference, Release 24. Nutrient Data Laboratory Home Page. http://www.ars.usda.gov/ba/bhnrc/ndl

Usenik V, Fabčič J, Stampar F (2008) Sugars, organic acids, phenolic composition and antioxidant activity of sweet cherry (*Prunus avium* L.). Food Chem 107(1): 185–192

Vinciguerra V, Luna M, Bistoni A, Zollo F (2003) Variation in the composition of the heartwood flavonoids of *Prunus avium* by on-column capillary gas chromatography. Phytochem Anal 14(6):371–377

Webster AD, Looney NE (1995) Cherries: crop physiology, production and uses. CAB International, Wallingford, 513pp

Yoo KM, Al-Farsi M, Lee HJ, Yoon HG, Lee CY (2010) Antiproliferative effects of cherry juice and wine in Chinese hamster lung fibroblast cells and their phenolic constituents and antioxidant activities. Food Chem 123(3):734–740