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Review

A comprehensive review on pharmacognosy, phytochemistry and pharmacological activities of 8 potent *Prunus* species of southeast Asia

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Abstract

Genus *Prunus* comprising around 430 species is a vast important genus of family Rosaceae, subfamily amygdalaoidae. Among all 430 species, around 19 important species are commonly found in Indian sub-continent due to their broad nutritional and economic importance. Some most common species of genus *Prunus* are *Prunus amygdalus, Prunus persica, Prunus armeniaca, Prunus avium, Prunus cerasus, Prunus cerasoides, Prunus domestica, Prunus mahaleb*, etc. A newly introduced species of *Prunus i.e Prunus sunhangii* is recently discovered which is morphologically very similar to *Prunus cerasoides*. Plants of *Prunus* species are short to medium-sized deciduous trees mainly found in the northern hemisphere. In India and its subcontinent, it extends from the Himalayas to Sikkim, Meghalaya, Bhutan, Myanmar *etc*. Different *Prunus* species have been extensively studied for their morphological, microscopic, pharmacological and phytoconstituents characteristics. Total phenolic content of *Prunus* species explains the presence of phenols in high quantity and pharmacological activity due to phenols. Phytochemical screening of species of genus *Prunus* shows the presence of wide phytoconstituents which contributes in their pharmacological significance and reveals the therapeutic potential and traditional medicinal significance of this genus. Genus *Prunus* showed a potent antioxidant activity analyzed by 1,1-diphenyl-2-picryl-hydrazyl radical assay. Plant species belonging to the genus *Prunus* is widely used traditionally for the treatment of various disorders. Some specific *Prunus* species possess potent anticancer, anti-inflammatory, hypoglycemic etc. activity which makes the genus more interesting for further research and findings. This review is an attempt to summarize the comprehensive study of Prunus species from its distribution, morphological characters to phytoconstituents, and pharmacological activity.

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Keywords: Rosaceae; Prunus; antineoplastic agents; hypoglycemic agents; distribution; phytochemistry; review

1. INTRODUCTION

Being the 19th most prominent family of plants, "Rosaceae" has its diversity and importance.[1, 2] The name "Rosaceae" was first published by Michael Adanson. Still, “The International Code of Nomenclature for algae plants and fungi” (ICN) accepted Antoine Laurent de Jussieu as its initial autho.[3]

Genus *Prunus* belongs to the family Rosaceae, a subfamily Amygdalaceae.[4] It consists of around 430 species of evergreen and deciduous trees and shrubs, mainly distributed in the northern hemisphere and temperate zones.[5, 6] The species of the *Prunus* genus are having various characteristic features including leaf glands, an upper ovary, a single carpel, each carpel has two drooping artificial ovules, and stone fruit, which has a juicy mesocarp, fleshy or dry, and does not divide when mature, or in splits on its own in rare cases.[7]

Shi *et al* [10] divided the genus *Prunus* into three subgenera using DNA analysis, *Cerasus*, *Padus*, and *Prunus*.[8-10] Species name have been checked by “The plant list” http://www.theplantlist.org/ on 5/10/2022 at 16:30, and found that *Prunus sunhangii* a newly introduced species is not included in the list yet.

2. TRADITIONAL USES

The species of the genus *Prunus* are rich in phytoconstituents which are responsible for various medicinal properties. *Prunus avium (L.) L.* and *Prunus cerasus L.* (stems and seed extract shows

cardioprotective activity.[11] The flowers and leaves of *Prunus spinosa L.* have lithotriptic and diuretic activity and are useful in peptic ulcers.[12] *Prunus salicina Lindl.* fruit is used to treat arthritis.[13] The water extract of small branches of *Prunus cerasoides Buch.-Ham. ex D.Don* can be used as an anti-abortion agent.[14] Leaves and flowers are used in the treatment of kidney stones and gravel illness. Its heartwood can also be used to treat skin discoloration and sprains.[15]

Fang *et al* [16] in his study using chicken chorioallantoic membrane and Matrigel plug assays, found that apigenin under normoxic conditions, blocks VEGF and HIF-1 expression in human ovarian cancer cells, and effectively reduces tumor angiogenesis *in vivo.*

Luteolin, another flavone found in *Prunus* species, showed antiproliferative activity in cancer cells and inhibits invasion of prostate cancer PC3 cells through E-cadherin.[17] Luteolin prevents spontaneous lung metastasis of PC3 cells transplanted into nude mice *in vivo* which indicated that luteolin might be a potential treatment for aggressive cancer of the prostate gland.[18]

The flavonoid chrysin (20) is present in many species of the genus *Prunus*, including the *Prunus cerasus L.* and has been shown to have anticancer properties. It is an effective HIF-1 inhibitor and suggests new insights into the mechanism of action of chrysin (20) upon malignant tumors.[19] In the 1,1-diphenyl-2-picryl-hydrazyl radical radical scavenging experiment, Kaempferol (14), quercitrin, and multiforin extracted from *Prunus tomentosa Thunb.* and *Prunus persica (L.)* Batsch showed intense antioxidant activity.[20]

3. MEDICINAL AND ECONOMIC IMPORTANT SPECIES OF GENUS *PRUNUS*

Different species of the genus *Prunus* have different medicinal and economic importance. The most common 8 species of the genus *Prunus* having traditional medicinal importance and are commonly found in India are listed in Table 1.[21]

4. SPECIES AND THEIR GEOGRAPHICAL DISTRIBUTION

Most of the species belonging to the genus *Prunus* originated from China and 19 species are found in India. All, these 8 species are widely distributed from Himachal (India) to Bhutan, Sikkim, Nepal, Thailand, Myanmar, and Western China.[29] They are also cultivated in the regions of Japan, and the US. The distribution of species and their medicinal importance are summarized in Table 2.

Prunus amygdalus Batsch Batsch (*Almond*), a plant of both medicinal and economic value is native to West Asia and also grown in Baluchistan, Punjab, Kashmir, Persia, Afghanistan, and the Mediterranean region. The US is the largest producer of almonds, cultivated mainly in California.[30] Gharwal hills in the temperate zone of Uttarakhand, including the Pauri Tehri, Chamoli, and Uttarkashi regions, also cultivated in the Danolti and Gharwal regions.[31]

5. MORPHOLOGY OF DIFFERENT SPECIES OF GENUS *PRUNUS*

Komarov, 1971 classified genus *Prunus* in different subgenera. Further, Strasburger *et al,*[32] 1991 characterized these subgenera based on its unique morphological characteristics, such as the ripple pattern of the leaves in the bud, the inflorescence of the brush or brush, the size and color of the flower, the characteristics of the fruit, bones, and seed. Morphological characters of different species of *Prunus* are described in Table 3.

6. CHEMICAL CONSTITUENTS OF GENUS *PRUNUS*

Genus *Prunus* is rich in phytoconstituents including saponins, sterols, alkaloids, terpenoids, flavonoids, tannins, and phenolic acid are the main phytoconstituents responsible for pharmacological activities. Table 4 shows the presence of various phytoconstituents in methanol extract of different species of *Prunus,*[40] and the compounds isolated from them are summarized in Table 5.[41-74] A brief chart of a chemical constituent of 8 medicinally important *Prunus* species with their pharmacological activity has been given in Table 6.[40]

7. COMMERCIAL PREPARATIONS OF PRUNUS SPECIES:

Various species of genus *Prunus* are available in market either in the form of pure herbal extract or in a composition for the treatment of various ailments and disorder. Commercial preparations of *Prunus* species available in market and its composition are summarized in Table 7.

Table 1 Medicinal and economic important species of genus Prunus

S. No.	Species	Common name	Part used	Reference
1	*Prunus amygdalus Batsch*	Almond (Badam)	Bark, stem, fruit	22
2	*Prunus persica (L.) Batsch*	Peach	Bark, stem, fruit and leaves	23
3	*Prunus armeniaca L.*	Apricot	Bark, seed kernels, fruit	24
4	*Prunus cerasus L.*	Sour cherry	Stem, leaves, and fruit	25
5	*Prunus avium (L.) L.*	Sweet cherry	Fruit and seeds	25
6	*Prunus cerasoides Buch.-Ham. ex D.Don*	Wild cherry	Stem, bark, leaves, and fruit	26
7	*Prunus domestica L.*	Common Plum/European Plum	Bark, heartwood, fruit and leaves	27
8	*Prunus mahaleb L.*	Mahaleb	Fruit	28

Table 2 Species with their native and cultivation area and their medicinal aspects

S. No.	Species	Common name	Distribution	Medicinal aspect	Reference
1	*Prunus amygdalus Batsch*	Almond	Native of West Asia and grown in Baluchistan, Kashmir, Punjab, Afghanistan, Persia, and the Mediterranean region. The US is the largest producer yet grown in California.	Rich in nutrition, demulcent, stimulant, nervine tonic, lithotriptic, diuretic, emollient, laxative, and, a sedative in cough, deobstruent, aphro-disiac actions. Also valuable for cough and obstruction clearance of the liver and spleen, skin eruption, peptic ulcer, and intestinal colic. The astringent action of unripe fruit acts against gum and mouth sores and ulcers. The oil bears laxative property, and is helpful in mental disabilities; it also gives relief to neurological and kidney pain.	22
2	*Prunus persica (L.) Batsch*	Peach	Mainly found in temperate regions of Asia and Southern Europe	Bark has sedative, stomachic, demulcent, anti-scorbutic, diuretic, and expectorant activity. Leaves have anthelmintic activity. The plant has antidiabetic, antioxidant, antimicrobial, antitumor, anticarcinogenic, and cholinesterase inhibitory activity.	23
3	*Prunus armeniaca L.*	Apricot	Native to Asia and North-Eastern China. Distributed in the regions of North Korea, North China, Manchuria, North Eastern Mongolia and Khingan mountains. In India, it is mainly found in Northern India.	It is used as an analgesic, anti-asthmatic, anthe-lmintic, antipyretic, emollient, antispasmodic, demulcent, emetic, antiseptic, expectorant, laxative, ophthalmic, anticarcinogenic, sedative, anti-platelet, and antimicrobial agent.	24
4	*Prunus cerasus L.*	Sour cherry	It is distributed in areas of Europe and southwest Asia. In India, it is grown in the regions of Kashmir, Kumaun, and Gharwal.	Antidiabetic, immunomodulatory, enhanced sleep, antioxidant and antimicrobial activity.	25
5	*Prunus avium (L.) L.*	Sweet cherry	They are mainly distributed in north Russia and temperate regions of Europe.	The stem has a diuretic and astringent effect. They are mainly used for cystitis, urinary retention, nephritis, and arthritis.	25
6	*Prunus cerasoides Buch.-Ham. ex D.Don*	Wild cherry	Mainly found in the regions of Himachal Pradesh in North-Central India to Bhutan, Sikkim, Nepal, Thailand, Myanmar, and Western China. Distributed in the Gharwal hills in the temperate zone of Uttarakhand, including the Pauri, Tehri, Chamoli, and Utakahi regions. Grown in the Danolti and Gharwal regions.	Antibacterial, diuretic, BPH protective, antioxidant and cytotoxic activity.	26
7	*Prunus domestica L.*	Common plum	They are mainly distributed in the regions of south-eastern Europe and south-western Asia.	Hypotensive, antihyperlipidemic, antioxidant, anticancer, anxiolytic, Hepato-protective, Antimicrobial, GIT effect, and antidiabetic.	27

8. CONCLUSION

Prunus has a diverse species and varietal biodiversity that is found in wild, semi-wild, and cultivated forms all over the world. Research has been done on the *Prunus* species and its pharmacological activity. However, many species widely used by local people are not yet explored much. The Discovery of the new species *Prunus sunhangii* opens a new door to research on the *Prunus* genus. Phytochemical studies have shown that different parts of plants of the genus *Prunus* contain different types of phytochemical compounds, which are the key factors for its wide pharmacological properties. This genus also has great ethnomedicinal significance and is used to treat medical illnesses traditionally. This study helps us to understand the similarity and differences in *Prunus* species, phytoconstituents present in various species, and their pharmacological and medicinal significance.

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10. REFERENCES

1. Hummer KE, Janick J. Rosaceae: taxonomy, economic importance, genomics, in Genetics and genomics of Rosaceae. Springer 2009; 6: 1-17.

Table 3 Morphological characters of species of genus Prunus

Species	Common name	Morphology			Reference
		Leaves	Flower	Fruit	
Prunus amygdalus Batsch	Almond	The deciduous tree is 4-10 m high, the trunk diameter can reach 30 cm, the leaves are gray, oblong-lanceolate, and the petiole is equal to or longer than the maximum leaf width.	Flowers are white with a crimson tinge, 3-5cm in diameter with five petals, emerging before the leaves.	The drupe is 3.5 to 6 cm long and is pubescent. The flesh is hard and splits when mature, exposing the bones. The endocarp is thin or thick, flat, long, oval seeds with brownish seed coats, usually surrounded by each stone shell.	30
Prunus persica (L.) Batsch	Peach	10 m evergreen tree, leaves are conduplicate in the bud, 6.3-10 cm long, lanceolate, hairy on the midrib underneath when young serrate, and the bark is grey or ashy,	Its flowers are pinkish-white sessile, 2.5-3 cm in diameter with five petals and pedicelled.	Yellow whitish fruit with a delicate aroma, velvety and smooth skin, red-brown single large seed, 1.3-2 cm long and oval and surrounded by a wood-like husk.	3
Prunus armeniaca L.	Apricot	The tree has a height of 800-1200 cm, a trunk diameter of up to 0.4 m, and a dense canopy. The leaves are ovate, 5-9 cm long, 4-8 cm wide, with round base, pointed tips, and serrated edges.	2-4.5cm five petals flowers pinkish at first then white, leaves after the flower, fascicled, short pedicel	Drupe 1.5-2.5 cm Smooth or glabrous, smooth or velvety skin, yellowish, reddish, smooth stones with thick bevels.	33
Prunus cerasus L.	Sour cherry	Its height ranges from 4 to 10 meters. ovate, rigid leaves round-topped or spreading and have root suckers	2-5 m long, white, clustered on thin pedicles, 2-4 cm long, stiff and abruptly pointed, minutely toothed	Fruits are globose, 0.6-1.25 cm in diameter, and appear with the leaves. Bright crimson to nearly black, acidic or sweet Bark is a kind of tree astringent, bitter fruit with a tart and sweet flavor.	34
Prunus avium (L.) L.	Sweet cherry	Similar to cerasus, but does not form rhizomes, loose leaves, thicker teeth, two glands at the top of the petiole	Buds are leafless but have larger reflective scales; sepals are usually intact	Blackish fruit, sweet, peduncles up to 5 cm long	35
Prunus cerasoides Buch.-Ham. ex D.Don	Himalayan wild cherry	Medium to large trees, mahogany, and horizontal bars. The leaves are smooth and hairless, ovate, long, and strongly serrated. The leaves are 7.5-12.5 cm long, and the petioles are 1.3 cm long.	White, pink, or crimson flowers appear in umbrella-like clusters in front of the leaves at the ends of branches.	The fruit is yellow-red, oval or spherical, 1.32 cm long	36
Prunus domestica L.	European plum/ common plum	An unarmed tree with glabrous branches, pubescent pedicles, and	Thorny, white blossom, borne in early spring	8 cm big, oblong, hanging drupes of purple-blackish color	37
Prunus mahaleb L.	Mahaleb	Upright heavily branched shrub, 1.5-5 cm long oval spreading leaves, subrounded ovate, briefly acuminate subcordate obtusely serrate.	Floral, pure white, small, 8 to 20 mm in diameter, 8 to 15 mm long stem, 3 to 10 racemes in 3 to 4 cm long racemes.	This fruit is a small cherry-colored drupe with thin flesh and a bitter taste. It is first green, then scarlet, and dark purple or black when mature.	38, 39

Table 4 Phytochemical screening of species of *Prunus*

Species	Terpenoids	Alkaloids	Flavanoids	Phenolic acid	Tannins
Prunus amygdalus Batsch	++	++	++	++	++
Prunus persica (L.) Batsch	--	--	++	++	++
Prunus armeniaca L.	++	++	++	++	++
Prunus cerasus L.	--	++	++	++	++
Prunus avium (L.) L.	--	++	++	++	++
Prunus cerasoides Buch.-Ham. ex D.Don	++	--	++	++	++
Prunus domestica L.	++	++	++	++	++
Prunus mahaleb L.	--	--	++	++	++

Notes: ++: Present; --: absent.

Table 5 Chemical constituents of 8 *Prunus* species

Species	Flavanoids	Steroids/terpenes	Phenolic acid	Coumarins	Carotenoids
Prunus amygdalus Batsch	Naringenin, Prunin, Isoquercetrin	Amygdaloside, Amygdalactone, Betulinic acid, Maslinic acid	5-O-Caffeoyl quinic acid, chlorogenic acid, protocatechuic acid	Coumarinic acid	
Prunus persica (L.) Batsch	Hesperetin 5-O-ß-D-glucoside, Naringenin, Persiconin, Prunin/Naringenin 7-O-ß-D glucopyranoside Isoquercetrin, Kaempferol	5-Avenasterol, 2,3-Dihydroxy olean-12-en-28-oic acid, 2,3 Dihydroxyurs-12-en-28-oic acid	cis, trans (+) Abscisic acid, Chlorogenic acid		Trans-Au roxanthin, Carotene, Lutein, Zeaxanthin
Prunus armeniaca L.	3,4′,5,7- Tetrahydroxy-3′,5′-di-methoxy flavone 3-O-[α-L-rhamnopyranosyl (1'''→6''')-ß-D-galactopyranoside, Naringenin, Kaempferol, Prunin, Isoquercetrin	α-Amyrin acetate 5-Avenasterol Cholesterol, Estrone	5-O-Caffeoylquinic acid p-Coumaric acid Chlorogenic acid Protocatechuic acid		Carotene Lycopene
Prunus cerasus L.	Apigenin-5-glucoside, Chrysin, 6,7-Dimethoxy-5,8,4'-trihydroxyflavone, Glucogenkwanin, Tectochrysin, Tectochrysin- 5-glucoside, Cerasinone, Dihydrotectochrysin, Naringenin, Sakuranetin, Isoquercetrin, Kaempferol	5-Avenasterol 7-Avenasterol	Caffeic acid, 5-O-Caffeoylquinic acid, p-Coumaric acid, Chlorogenic acid, Protocatechuic acid		Carotene Lutein Zeaxanthin
Prunus avium (L.) L.	Aequinoctin or chrysin-7-glucoside, Chrysin, Chrysin-7-O-glucoside, Galangin, Jaceidin, Tectochrysin, Dihydrotectochrysin, Naringenin, Prunin, Sakuranetin, Kaempferol		Caffeic acid p-Coumaric acid o-Coumaric acid Chlorogenic acid		
Prunus cerasoides Buch.-Ham. ex D.Don	Glucogenkwanin Naringenin Naringenin-4'-methylether-7-xyloside Naringenin-4'-O-methylliquiritigenin-7-O-α-L-rhamnopyranoside Naringenin-5-O—L rhamnopyranoside Puddumin-A Puddumin-B Afzelin	ß-sitosterol Ursolic acid			
Prunus domestica L.	Chrysin Isosakuranetin Naringenin Isoquercetrin Kaempferol	5-Avenasterol	cis, trans (+) Abscisic acid, Caffeic acid, 5-O-Caffeoylquinic acid, p-Coumaric acid, Chlorogenic acid, Protocatechuic acid, Vanillic acid	Fraxinol Magnolioside	Apo12'-violaxanthal-Carotene Lutein
Prunus mahaleb L.	Naringenin Prunin or Naringenin 7-O-ß-D-glucopyranoside Kaempferol		o-Coumaric acid	Coumarin Esculetin Herniarin Herniarin glucoside Mahaleboside Umbelliferone	

2. Rasheed HM, Khan T, Wahid F, et al. Chemical composition and vasorelaxant and antispasmodic effects of essential oil from Rosa indica L. petals. Evid Based Complementary Altern Med 2015; 2015: 1-9.
3. Kant R, Shukla RK, Shukla A. A review on peach (Prunus persica): an asset of medicinal phytochemicals. Int J Res Appl Sci Eng Technol 2018; 6: 2186-200.
4. Lee S, Wen J. A phylogenetic analysis of *Prunus* and the Amygdaloideae (Rosaceae) using ITS sequences of nuclear ribosomal DNA. Am J Bot 2001; 88: 150-60.
5. Poonam V, Kumar G, Reddy LC, et al. Chemical constituents of the genus *Prunus* and their medicinal properties. Curr Med Chem 2011; 18: 3758-824.
6. Bhatnagar S, Sastri B. The wealth of India raw materials (a dictionary of indian raw materials and industrial products). New Delhi, India 1960; 10: 64-8.

Table 6 Chemical constituents of different *Prunus* species and their pharmacological activity

Species	Chemical constituents	Pharmacological action	Reference
Prunus amygdalus Batsch	Betulinic acid	Anti-proliferative activity	75
	Chlorogenic acid	Anti-ulcer, antimicrobial, antioxidant, anti-aging	76
	Amygdalactone	Anti-proliferative, anti-platelet	75
	Naringenin	Anti-estrogen, anti-oxidant	77
	Kaempferol	Antimicrobial against herpes-simplex virus, antioxidant	78
	Amygdaloside	Anti-inflammatory, antitumor, antibacterial, and analgesic	62
Prunus persica (L.) Batsch	Hesperetin	Anti-hyperlipidemia, anti-inflammatory	78
	Genistein	Cardioprotective treats osteoporosis	79
	Oleanolic acid	Anti-inflammatory, anti-arthritic agent, anti-lipase activity	80
	Zeaxanthin	Antioxidant	81
	Lutein	Visual disorders and cognition disease	72
Prunus armeniaca L. L	Naringenin	Anti-estrogen, antioxidant	82
	Kaempferol	Antimicrobial against herpes simplex virus	78
	Isoquercitrin	Anticancer	83
	Estrone	Anticancer	83
	Carotene	Antioxidant	81
	Lycopene	Anti-inflammatory, anti-proliferative	81
Prunus cerasus L.	Cyanidin	Antioxidant, anti-inflammatory	84
	Apigenin-5-glucoside	BZD antagonist	85
	Tectochrysin	Anti-tumor	44
	Naringenin	Anti-estrogen	82
	Sakuranetin	Anti-cancer	86
	Isoquercitrin	Anti-oxidant	83
	Kaempferol	Anti-microbial	78
Prunus avium (L.) L.	Kaempferol	Antioxidant antimicrobial	78
	Galangin	Antioxidant, anti-fibrotic, antibacterial	87
	Jaceidin	Anti-tumour	88
	Tectochrysin	Anti-tumour	44
	Naringenin	Anti-estrogen	82
	Sakuranetin	Anti-cancer	86
Prunus cerasoides Buch.-Ham. ex D.Don	Apigenin	BZD antagonist	85
	Beta-sitosterol	Antimicrobial, anti-hyperlipidemic, BPH	89
	Sakuranetin	Anticancer	86
	Prunetin	Anti-inflammatory	90
	Genkwanin	Anti-inflammatory	90
	Ursolic acid	Cardioprotective	91
Prunus domestica L.	L-ascorbic acid	Antioxidant activity	92
	NeoChlorogenic acid	Neuroprotective effect	93
	Quercetin-3-o-rutinoside	Anticancer	94
	Quercetin-3-o-glucoside	Anti-diabetic and anti-oxidant	95
	Methyl-3-caffeoylquinic	Antioxidant	96
	Chlorogenic acid	Hepatoprotective, anxiolytic	97
	Protocatechuic acid	Antibacterial, anticancer	98
Prunus mahaleb L.	Coumarin	Anti-coagulant, anti-inflammatory	70
	Dihydrocoumarin	Antioxidant and antitumor	28
	Esculetin	MAO inhibitor, AChE inhibitor	99
	Herniarin	Cytotoxic	99
	Umbelliferone	Anti-hypoglycemic, antitumor	100
	Kaempferol	Anti-oxidant, antimicrobial	78
	Naringenin	Anti-estrogen, anti-oxidant	84

7. Zhang X, Jiang Z, Yusupov Z, et al. *Prunus* sunhangii: a new species of *Prunus* from central China. Plant diversity 2019; 4: 19-25.
8. Leather SR. *Prunus padus L*. J Ecol 1996; 84: 125-32.
9. Hodel RG, Zimmer E, Wen J. A phylogenomic approach resolves the backbone of *Prunus* (*Rosaceae*) and identifies signals of hybridization and allopolyploidy. Mol Phylogenet Evol 2021; 160: 107-18.
10. Shi S, Li J, Sun J, et al. Phylogeny and classification of *Prunus sensu lato* (*R osaceae*). J Integr Plant Biol 2013; 55: 1069-79.
11. B Hanbali L, J Haddad J. The antioxidant properties of red sour cherry (*Prunus cerasus L*.) extracts: laboratory assessment of antioxidant activity and antioxidant compounds under temperature variations. Curr Nutr Food Sci 2015; 11: 31-43.
12. Sabatini L, Fraternale D, Giacomo B, et al. Chemical composition, antioxidant, antimicrobial and anti-inflammatory activity of *Prunus spinosa L*. fruit ethanol extract. J Funct Foods 2020; 67: 1-10.
13. Lim T. *Prunus salicina*, in edible medicinal and non-medicinal plants. Springer 2012; 4: 509-14.

Table 7 Commercial preparations of *Prunus* species

Brand name	Part used	Use	Marketed by
Roghan Badam Shireen	Ripe kernels of *Prunus amygdalus*.	Sharpens brain, headache spasm, insomnia.	Dabur
Peach Kernel Oil	Kernels	It soothes redness and swollen skin. It hydrates and moisturizes dry skin. It improves skin elasticity and leaves a soft touch It slows down the aging process and deals with the fine lines and wrinkles	Salvia
Coldpress Apricot Carrier Oil	Kernels of *Prunus armeniaca*	skin retain elasticity, clarity, and suppleness	Naturalis
Peach liquid extract	Peach Fruit extract	It works as a natural moisturizer. Vitamin C and E are antioxidants present in peach that helps wound recover faster and prevent aging of the skin by reducing oxygen-free radicals.	Herbal creations
Old Indian Cherry Bark Syrup	Apricot seed, Black cherry bark	Boost immunity	Planetary herbals

14. Joshi SR. Himalayan cherry *Prunus cerasoides*. Bee World 2004; 85: 73-3.
15. Arora DS, Mahajan HJ. biotechnology. Major Phytoconstituents of Prunus cerasoides responsible for antimicrobial and antibiofilm potential against some reference strains of pathogenic bacteria and clinical isolates of MRSA. Appl Biochem Biotechnol 2019; 188: 1185-204.
16. Fang J, Zhou Q, Liu Z, et al. Apigenin inhibits tumor angiogenesis through decreasing HIF-1α and VEGF expression. J Carcinog 2007; 28: 858-64.
17. Liu W, Nan G, Nisar MF, et al. Chemical constituents and health benefits of four Chinese plum species. J Food Qual 2020; 2020: 1-17.
18. Zhou Q, Yan B, Hu X, et al. Luteolin inhibits invasion of prostate cancer PC3 cells through E-cadherin. Mol Cancer Ther 2009; 8: 1684-91.
19. Fu B, Xue J, Li Z, et al. Chrysin inhibits expression of hypoxia-inducible factor-1α through reducing hypoxia-inducible factor-1α stability and inhibiting its protein synthesis. Mol Cancer Ther 2007; 6: 220-6.
20. Kim SK, Kim HJ, Choi SE, et al. Anti-oxidative and inhibitory activities on nitric oxide (NO) and prostaglandin E 2 (COX-2) production of flavonoids from seeds of Prunus tomentosa Thunberg. Arch Pharm Res 2008; 31: 424-8.
21. Das B, Ahmed N, Singh P. Prunus diversity-early and present development: a review. Int J Biodivers Conserv 2011; 3: 721-34.
22. Kester DE, Gradziel TM, Grasselly C, et al. Almonds (*Prunus*). Genetic resources of temperate fruit and nut crops. Acta Hortic 1991; 290: 701-60.
23. Scorza R, Okie WR. Peaches (*Prunus*). Genetic resources of temperate fruit and nut crops. Acta Hortic 1991; 290: 177-234.
24. Mehlenbacher SA, Cociu V, Hough F. Apricots (*Prunus*). Genetic resources of temperate fruit and nut crops. Acta Hortic 1991; 290, 65-110.
25. Blando F, Gerardi C, Nicoletti I. Sour cherry (*Prunus cerasus L*) anthocyanins as ingredients for functional foods. J Biomed Biotechnol 2004; 2004: 253-8.
26. Tiwari C, Chubey S, Kurele R, et al. A Review on padmaka *(prunus cerasoides d. don*): different species and their medicinal uses. Ayushdhara 2016; 4: 1051-5.
27. Dhingra N, Sharma R, Kar A. Antioxidative and antiproliferative activities of isolated compounds from Prunus domestica: an *in vitro* study. Int J Phytomedicine 2013; 5: 341-6.
28. Al-Said MS, Hifnawy MS. Dihydrocoumarin and certain other coumarins from *Prunus mahaleb* seeds. J Nat Prod 1986; 49: 721.
29. Joseph N, Anjum N, Tripathi Y. *Prunus cerasoides D. Don*: a review on its ethnomedicinal uses, phytochemistry and pharmacology. Int J Pharm Sci 2018; 48: 62-9.
30. Kester DE, Gradziel TM. Grasselly C. Almonds (*Prunus*). Genetic resources of temperate fruit and nut crops. Acta Hortic 1991; 290: 701-58.
31. Rana T, Chandel V, Hallan V. Himalayan wild cherry (*Prunus cerasoides D. Don*): a new host of Apple chlorotic leaf spot virus. For Pathol 2008; 38: 73-7.
32. Strasburger E, Noll F, Schenck H, Schimper AF. Text book of botany for univertities. 33 ed. Jena: Gustav Fischer Verlag, 1991: 778-80.
33. Ruiz D, Egea J. Phenotypic diversity and relationships of fruit quality traits in apricot (*Prunus armeniaca L.*) germplasm. Euphytica 2008; 163: 143-58.
34. Fathi M, Mohebbi M, Koocheki A. Introducing prunus cerasus gum exudates: chemical structure, molecular weight, and rheological properties. Food Hydrocoll 2016; 61: 946-55.
35. Beyer M, Hahn R, Peschel S, et al. Analysing fruit shape in sweet cherry (*Prunus avium L.*). Sci Hortic 2002; 96: 139-50.
36. Jangwan J, Kumar N. Isolation and Characterization of new flavonoid glycoside from the seeds of *Prunus cerasoides*. J Med Pl Stud 2015; 3: 20-2.
37. Kayano S, Kikuzaki H, Fukutsuka N, et al. Antioxidant activity of prune (*Prunus domestica L.*) constituents and a new synergist. J Agric Food Chem 2002; 50: 3708-12.
38. Guitian J. Why Prunus mahaleb (*Rosaceae*) produces more flowers than fruits. Am J Bot 1993; 80: 1305-9.
39. Potter, D. Prunus. In: Kole C. Wild crop relatives: genomic and breeding resources. Heidelberg: Springer, 2011: 129-45.
40. Joseph N, Anjum N, Tripathi Y. Phytochemical screening and evaluation of polyphenols, flavonoids and antioxidant activity of *Prunus cerasoides D. Don* leaves. J Pharm Res 2016; 10: 502-8.
41. Vogt T. Phenylpropanoid biosynthesis. Molecular plant 2010; 3: 2-20.
42. Iwashina T. The structure and distribution of the flavonoids in plants. J Plant Res 2000; 113: 287.
43. Panche A, Diwan A, Chandra S. Flavonoids: an overview. J Nutr Sci 2016; 5: 1-15.
44. Geibel M, Geiger H, Treutter D. Tectochrysin 5-and genistein 5-glucosides from the bark of *Prunus cerasus*. Phytochemistry 1990; 29: 1351-3.
45. Nagarajan GR, Parmar VS. Three new flavonoids in *Prunus cerasus*. Phytochemistry 1977; 16: 1317-8.
46. Jung HA, Kim AR, Chung HY, Choi JS. *In vitro* antioxidant activity of some selected *Prunus* species in Korea. Arch Pharm Res 2002; 25: 865-72.
47. Ohtsuki K, Abe A, Mitsuzumi H, et al. Effects of long-term administration of hesperidin and glucosyl hesperidin to spontaneously hypertensive rats. J Nutri Sci Vitam 2002; 48: 420-22.
48. Bugianesi R, Catasta G, Spigno P, et al. Naringenin from cooked tomato paste is bioavailable in men. J Nutri 2002; 132: 3349-52.
49. Nakamura S, Fujimoto K, Matsumoto T, et al. Structures of acylated sucroses and an acylated flavonol glycoside and inhibitory effects of constituents on aldose reductase from the flower buds of *Prunus mume*. J Nat Med 2013; 67: 799-806.
50. Veličković JM, Kostić DA, Stojanović GS, et al. Phenolic composition, antioxidant and antimicrobial activity of the extracts

from Prunus spinosa L. Fruit Hem Ind 2014; 68: 297-303.
51. Chen K, Ohmura W, Doi S, Aoyama M. Termite feeding deterrent from Japanese larch wood. Bioresour Technol 2004; 95: 129-34.
52. Mertens S, Talcott S, Percival S. Low Concentrations of quercetin and ellagic acid synergistically influence proliferation, cytotoxicity and apoptosis in MOLT-4 human leukemia cells. J Nutr 2003; 133: 2669-74.
53. Reed J. Cranberry flavonoids, atherosclerosis and cardiovascular health. Crit Rev Food Sci Nutr 2002; 42: 301-16.
54. Haraguchi H, Mochida Y, Sakai S, et al. Protection against oxidative damage by dihydroflavonols in Engelhardtia chrysolepis. Biosci Biotechnol Biochem 1996; 60: 945-8.
55. Wei H, Bowen R, Cai Q, Barnes S, Wang Y. Antioxidant and antipromotional effects of the soybean isoflavone genistein. Proceedings of the Society for Experimental Biology and Medicine 1995; 208: 124-30.
56. Tham DM, Gardner CD, Haskell WL. Potential health benefits of dietary phytoestrogens: a review of the clinical, epidemiological, and mechanistic evidence. J Clin Endocrinol Metab 1998; 83: 2223-35.
57. Bagchi D, Bagchi M, Stohs SJ, et al. Free radicals and grape seed proanthocyanidin extract: importance in human health and disease prevention. Toxicology 2000; 148: 187-97.
58. Howell AB. Cranberry proanthocyanidins and the maintenance of urinary tract health. Crit Rev Food Sci Nutr 2002; 42: 273-8.
59. Wang H, Nair MG, Strasburg GM, Booren AM, Gray JI. Antioxidant polyphenols from tart cherries (*Prunus cerasus*). J Agric Food Chem 1999; 47: 840-4.
60. Wang H, Nair MG, Iezzoni AF, et al. Quantification and characterization of anthocyanins in Balaton tart cherries. J Agric Food Chem 1997; 45: 2556-60.
61. Lahlou H, Hirai N, Tsuda M, Ohigashi H. Triterpene phytoalexins from nectarine fruits. Phytochemistry 1999; 52: 623-9.
62. Amico V, Barresi V, Condorelli D, Spatafora C, Tringali C. Antiproliferative terpenoids from almond hulls (*Prunus dulcis*): identification and structure activity relationships. J Agric Food Chem 2006; 54: 810-4.
63. Sang S, Li G, Tian S, et al. An unusual diterpene glycoside from the nuts of almond (*Prunus amygdalus Batsch*). Tetrahedron lett 2003; 44: 1199-202.
64. Sang S, Cheng X, Fu H, et al. New type sesquiterpene lactone from almond hulls (*Prunus amygdalus Batsch*). Tetrahedron Lett 2002; 43: 2547-49.
65. Singh G, Singh S, Bani S. Oleanolic acid. Drugs Future 1994; 19: 450-1.
66. Kashiwada Y, Wang H, Nagao T, et al. Anti-AIDS agents. 30. Anti-HIV activity of oleanolic acid, pomolic acid, and structurally related triterpenoids. J Nat Prod 1998; 61: 1090-5.
67. Kayano S, Kikuzaki H, Hashimoto S, et al. Structural elucidation of new glucosyl terpenates isolated from prunes (*Prunus domestica L.*). Koryo, Terupen oyobi Seiyu Kagaku ni kansuru Toronkai Koen Yoshishu 2004; 48: 297.
68. Kim DO, Chun OK, Kim YJ, Moon HY, Lee CY. Quantification of polyphenolics and their antioxidant capacity in fresh plums. J Agric Food Chem 2003; 51: 6509-15.
69. Garofulić IE, Jambrak AR, Milošević S, et al. The effect of gas phase plasma treatment on the anthocyanin and phenolic acid content of sour cherry Marasca (*Prunus cerasus var. Marasca*) juice. LWT-Food Sci Technol 2015; 62: 894-900.
70. Ieri F, Pinelli P, Romani A. Simultaneous determination of anthocyanins, coumarins and phenolic acids in fruits, kernels and liqueur of *Prunus mahaleb L*. Food chem 2012; 135: 2157-62.
71. Ruiz D, Egea J, Tomás F, Gil MI. Carotenoids from new apricot (*Prunus armeniaca L.*) varieties and their relationship with flesh and skin color. J Agric Food Chem 2005; 53: 6368-74.
72. Zaghdoudi K, Pontvianne S, Framboisier X, et al. Accelerated solvent extraction of carotenoids from: Tunisian Kaki (*Diospyros kaki L.*), peach (*Prunus persica L.*) and apricot (*Prunus armeniaca L.*). Food Chem 2015; 184: 131-9.
73. Vetter J. Plant cyanogenic glycosides. Toxicon 2000; 38: 11-36.
74. Kim GJ, Choi HG, Kim JH, et al. Anti-allergic inflammatory effects of cyanogenic and phenolic glycosides from the seed of *Prunus persica*. Nat Prod Commun 2013; 8: 1739-40.
75. Amico V, Barresi V, Condorelli D, Spatafora C, Tringali C. Antiproliferative terpenoids from almond hulls (*Prunus dulcis*): identification and structure activity relationships. J Agric Food Chem 2006; 54: 810-4.
76. Tungmunnithum D, Abid M, Elamrani A, Drouet S, Addi M, Hano C. Almond skin extracts and chlorogenic acid delay chronological aging and enhanced oxidative stress response in yeast. Life 2020; 10: 80-9.
77. Murathan ZT, Kaya A, Erbil N, et al. Comparison of bioactive components, antimicrobial and antimutagenic features of organically and conventionally grown almond hulls. Erwerbs-Obstbau 2020; 62: 463-72.
78. Musarra M, Ginestra G, Smeriglio A, et al. The antimicrobial and antiviral activity of polyphenols from almond (*Prunus dulcis L.*) skin. Nutrients 2019; 11: 2355-62.
79. Jesus F, Goncalves A, Alves G, Silva L. Health benefits of Prunus avium plant parts: An unexplored source rich in phenolic compounds. Food Rev Int 2020; 38: 1-29.
80. Nakagawa T, Allam AE, Ohnuki K, Shimizu K. Biological activities of extracts from different parts of two cultivars of *Prunus persica* 'Akatsuki'and 'Fastigiata'. Nat Prod Commun 2018; 13. doi:10.1177/1934578X1801301015.
81. Oliveira A, Pintado M, Almeida DP. Phytochemical composition and antioxidant activity of peach as affected by pasteurization and storage duration. LWT-Food Sci Technol 2012; 49: 202-7.
82. Patel K, Singh GK, Patel DK. A review on pharmacological and analytical aspects of naringenin. Chin J Integr Med 2018; 24: 551-60.
83. Won Y, Kim J, Lizardo R, et al. The flavonol isoquercitrin promotes mitochondrial-dependent apoptosis in SK-Mel-2 melanoma cell *via* the PI3K/AKT/mTOR pathway. Nutrients 2020; 12: 3683-90.
84. Bell PG, Gaze DC, Davison GW, et al. Montmorency tart cherry (*Prunus cerasus L.*) concentrate lowers uric acid, independent of plasma cyanidin-3-O-glucosiderutinoside. J Funct Foods 2014; 11: 82-90.
85. Beszterda M, Frański R. Detection of flavone C-glycosides in the extracts from the bark of *Prunus avium L.* and *Prunus cerasus L.* Eur J Mass Spectrom 2020; 26: 369-75.
86. Stompor M. A review on sources and pharmacological aspects of sakuranetin. Nutrients 2020; 12: 513.
87. McNulty J, Nair J, Bollareddy E, et al. Isolation of flavonoids from the heartwood and resin of Prunus avium and some preliminary biological investigations. Phytochemistry 2009; 70: 2040-6.
88. Singh J, Jayaprakasha G, Patil BS. Extraction, identification, and potential health benefits of spinach flavonoids: a review. Advances in plant phenolics: from chemistry to human health. ACS Symposium Series 2018; 1286: 107-36.
89. Jena AK, Vasisht K, Karan M. Therapeutic management of benign prostatic hyperplasia: from synthetics to naturals. Annu Res Rev Biol 2017; 17: 1-34.
90. Köksal Ç, Nalbantsoy A, Karabay N. Prunetin inhibits nitric oxide activity and induces apoptosis in urinary bladder cancer cells *via* CASP3 and TNF-α genes. Mol Biol Rep 2021; 48: 7251-9.
91. Khwaza V, Oyedeji OO, Aderibigbe BA. Ursolic acid-based derivatives as potential anti-cancer agents: An update. Int J Mol Sci 2020; 21: 5920-30.
92. Lombardi G, Lucarini M, Lanzi S, Aguzzi A, Cappelloni M. Nutrients and antioxidant molecules in yellow plums (*Prunus domestica L.*) from conventional and organic productions: a comparative study. J Agric Food Chem 2004; 52: 90-4.
93. Kim M, Choi SY, Lee P, Hur J. Neochlorogenic acid inhibits lipopolysaccharide-induced activation and pro-inflammatory responses in BV2 microglial cells. Neurochem Res 2015; 40: 1792-8.
94. Samanta SK, Bhattacharya K, Mandal C, Pal BC. Identification and quantification of the active component quercetin 3-O-rutinoside from Barringtonia racemosa, targets mitochondrial apoptotic pathway in acute lymphoblastic leukemia. J Asian Nat Prod Res 2010; 12: 639-48.

95. Panda S, Kar A. Apigenin (4 ‘, 5, 7-trihydroxyflavone) regulates hyperglycaemia, thyroid dysfunction and lipid peroxidation in alloxan-induced diabetic mice. J Pharm Pharmacol 2007; 59: 1543-8.
96. Zhao JG, Yan QQ, Xue RY, Zhang J, Zhang YQ. Isolation and identification of colourless caffeoyl compounds in purple sweet potato by HPLC-DAD–ESI/MS and their antioxidant activities. Food chem 2014; 161: 22-6.
97. Bouayed J, Rammal H, Dicko A, Younos C, Soulimani R. Chlorogenic acid, a polyphenol from *Prunus domestica* (Mirabelle), with coupled anxiolytic and antioxidant effects. J Neurol Sci 2007; 26: 77-84.
98. Kakkar S, Bais S. A review on protocatechuic acid and its pharmacological potential. Int Sch Res Notices 2014; 943-52.
99. Santamour Jr FS, Riedel LG. Distribution and inheritance of scopolin and herniarin in some *Prunus* species. Biochem Syst Ecol 1994; 22: 197-201.
100. Newary S, Afifi S, Aly M, et al. Chemical profile of Launaea nudicaulis ethanolic extract and its antidiabetic effect in streptozotocin-induced rats. Molecules 2021; 26: 1000.