REVIEW ARTICLE

Pharmacological and toxicity concerns of plant *Prunus armeniaca* including adoptive nanotechnology for precise delivery of their active constituents

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ABSTRACT

Prunus armeniaca is a well-known apricot. Its fruit kernel and seed are mostly reported for medicinal use. Neuroprotective, antidiabetic, and anticancer potentials are highlighted in scientific literature. Apart from medicinal applications, various scientific reports are available to confirm its potential toxic effect, especially in producing allergic symptoms, birth defects, and cyanide-like poisoning. Nowadays nanotechnological concepts are well applied in drug delivery systems to improve drug targetability with precision to avoid unnecessary exposure of drugs to tissues. Delivery of active constituents obtained from this plant is also taken as payload in silver and gold nanoparticles for efficacy assessment. The present literature summarizes the potential health benefits, toxicity, and nanotechnological advancement regarding this valuable medicinal plant. The review concise available scientific information in a single platform covering its traditional use, geographical location, and nutritional values.

Keywords: *Prunus armeniaca,* Nanotechnology, Allergy, Birth defects, Cyanide-like poisoning, Anticancer, Amygdalin.

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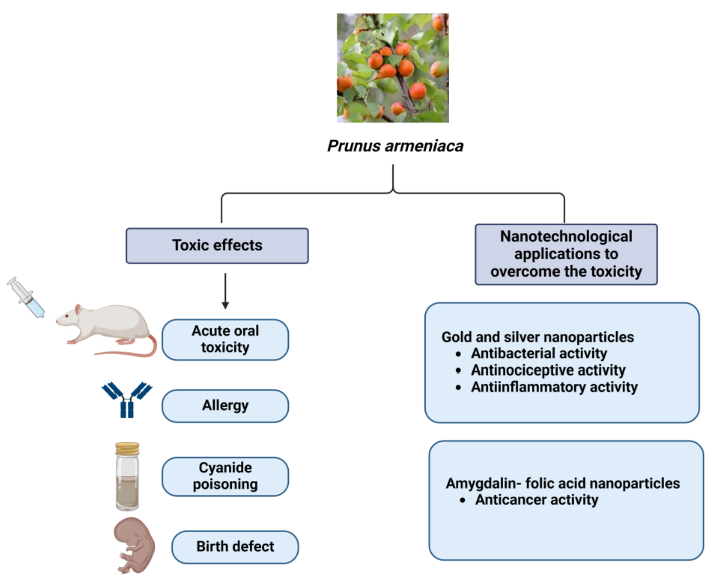

GRAPHICAL ABSTRACT

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INTRODUCTION

Prunus armeniaca (*P. armeniaca*), belonging to the Prunus genus and family *Rosaceae* is known as apricot, a stone fruit widely consumed throughout the world. It is famous as plums in America, wild variety is known as Zardalu or Chuli India. The *P. armeniaca* kernel exhibited antispasmolytic, anticestodals, antimicrobial, antimutagenic, antitussive, anti-inflammatory, antiparasitic, anticancer, antiaging, antiatherosclerosis, antianginal, cardioprotective, hepatoprotective, neuroprotective, antioxidants, anti-inflammatory properties and tonic effects. Also beneficial for colon inflammation and ulcers. [1] *P. armeniaca* is loaded with vitamin E which helps to protect hairfrom environmental damage. *P. armeniaca* has a large number of flavonoids that are beneficial in several cardiovascular and cerebrovascular diseases and also useful in the treatment of cancer, Parkinson's, and Alzheimer's disease. *P. armeniaca* is a low glycemic index food and helped in regulating blood sugar levels providing better blood glucose control.[2]

This fruit can be consumed fresh as well as after by processed. Juice, drinks, lyophilized products, jelly, and jam are well-reported in various parts of the world. Kernels of the plant contain a poisonous chemical called amygdalin, which is converted into cyanide in the abdomen. Laetrile, a semi-synthetic version of amygdalin, was reportedas an anticancer agent but has still not been approved by the US FDA.[2-3] The chemical structure ofthese two valuable chemical components obtained from this plant is presented in Figure 1. Therefore, the author takes an interest in reviewing this conflict via scientific reports. The present review summarizes the toxicity as well as therapeutic concerns of this potential plant. A retrospective literature survey has been performed using various search engines like PubMed database, and Google Scholar. A keyword used for the collection of the database is *Prunus armeniaca,* amygdalin, or laetrile, sometimes paired with cancer, patient,cyanide, or toxic. A novel drug delivery concept to enhance efficacy and safety with target ability is also included in the presented review article to provide data in a single platform for the readers.

Plant Profile

P. armeniaca can be cultivated from July to August every year. Its plant is about 26 to 39 feet long, trunk of up to 16 inches in diameter, and a dense. The leaves are ovate and about 2.0 to

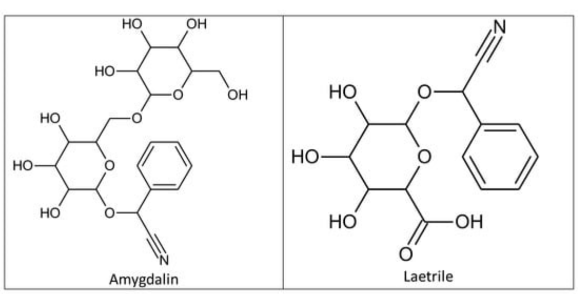

Figure 1: Chemical structure of amygdaline and its semi-synthetic version, laetrile

Figure 2: *P. armeniaca* plant with fruit

3.5 inches in length and 1.6 to 3.1 inches in width. A rounded base, pointy tip, and finely serrated border are characteristics of the leaf. The flowers are about 0.8 to 1.8 inches in diameter and white with pink petals. The plant bears yellow to orange color fruits that are oval with a size of about 0.6 to 1.0 inches in diameter. The orange color is turned to red color due to the sun exposure. The surface of the fruit is smooth (glabrous) with short hairs.[4] A *P. armeniaca* plant with fruitis represented in Figure 2 and the image of a fruit with kernelseed is represented in Figure 3.

It is transplanted by preparing cuttings in the nursery. Its graft is prepared by the method of seed, grafting, and graft pressing. *P. armeniaca* are planted in pits in the field. After the pits are ready, mix the appropriate amount of organic and chemical fertilizers in the soil and fill them. After filling the pits, irrigate them deeply. Due to this, the soil in the pits settles properly and becomes hard. Prepare these pits about three months before planting. After preparing the pits, cover them with pulao. While preparing pits in rows, there should be a space of about 5 to 6 meters between each pit. And there should be a distance of 5 meters between each row. Places with temperate and temperate climate are good for apricot cultivation. Its plants are not able to grow in hot weather. In contrast, they grow easily in the winter season. Its plants do not need much rain. Rain or extreme cold at the time of flowering is not suitable for it.[5]

Geographical Source

P. armeniaca is native to Central Asia and the Mediterranean region and easily occurs in geographical distribution such as America, Australia, Brazil, Britain, Canada, France, Germany,Kazakhstan, India Netherlands, etc.[6] Four different germplasms were identified Based on morphological and physiological properties, well-identified regions are Central

Figure 3: *P. armeniaca* fruit, kernel and seed

Asian, Dzhungar-Zailij, Irano-Caucasian, and European.[2] The largest apricot produceris Turkey worldwide with 7, 30,000 tons of production per year. Uzbekistan comes second with approximately 6.5 lakh tons of yearly production. California is the top apricot-producing state in the United States. Total U.S. apricot production was 41,470tons in 2021. According to a report published by Statista in September 2023, the United States imported over 88 million US dollars worth of dried *P. armeniaca* fruit. The top five apricot-producer countries are Turkey, Uzbekistan,Iran, Italy, and Algeria. Indian Himalaya region climate is also favourable for apricot cultivation and now Ladakh, an Indian union territory the largest producer of apricot fruit with an annual production of 15,000 tonners per year in Indian Territory. The entire area under apricot cultivation is 2,303 hectares.[10]

Plant Cultivation and Collection

P. armeniaca was first domesticated in China but is currently grown worldwide except in Antarctica. In terms of cultivation, *P. armeniaca* thrives in well-drained, moderately fertile soils and requires a sunny location to ensure optimal fruit production. The tree is grown in inter and moderately high temperatures in early summer and spring. The tree cannot be grown in a place with a subtropical climate. It is relatively hardy and can tolerate a range of climatic conditions, making it suitable for various regions.

P. armeniaca is propagated by budding on peaches, and peaches, plums, and apricots can easily be inter-grafted.[1]

P. armeniaca cultivation requires deep fertile loamy soil with proper drainage. Hard land with waterlogging is not suitable for its cultivation. The pH value of land should be around 7 is considered good for the production of *P. armeniaca*. To cultivate *P. armeniaca* effectively, it is necessary to make the soil friable and level by deep plowing the field. So there does not have to be faced with problems like waterlogging on the farm in the rainy season. After that, the pit should be prepared. For good growth and yield of *P. armeniaca* plants, an appropriate amount of manure and fertilizer should be given. A nitrogen-phosphorus-potassium in a ratio of 4:2:1 ideal composition of fertilizers for apricot production. The entire quantity of cow dung manure and phosphorus and potash should be given in December-January half the quantity of nitrogen should be given before flowering and the remaining half quantity should be given after one month. For good growth of *P. armeniaca* plants, irrigation is required at regular intervals and from time to time. Irrigation should be done as per requirement in the cold season, and irrigation should be done at an interval of 10 days in the summer season.[7]

P. armeniaca plants start yielding about three to four years after planting in the field. Fruiting on its plants starts in April. After which the fruits of its different varieties ripen from June to August. Pluck its fruits one or two days before they are fully ripe. So that fruits can be easily sent over long distances. When choosing ripe fruits of *P. armeniaca*, make sure they are slightly soft when pressed gently but still firm. Don't choose fruits that are too soft or mushy, as they may be too ripe and easily damaged. Its ripe fruits appear in different colors depending on the different varieties. Be careful when handling the fruits to avoid any damage to the skin. After picking the fruits, place them in a single layer in shallow containers so they don't get crushed. Make sure not to place them too high otherwise, the ones below may get crushed. The fruits were treated with a special gas called ethylene oxide for 3 days at 19˚C to help them ripen faster. *P. armeniaca* plants, once planted, give a yield of about 50 to 60 years. On average, around 80 kg of fruits can be obtained in a year from a fully-grown tree of its different varieties. Whose market price is found to be around 100 rupees per kg. Whereas after drying it gets more value.[7]

Nutritional Importance

P. armeniaca fruit has been reported rich in minerals, especially potassium, iron, manganese, and phosphorus with vitamins A, vitamins C, vitamins E, and fiber. In addition, apricots are a good source of fiber and carbohydrates. *P. armeniaca* fruit contains a noticeable amount of bone-strength minerals such as copper, potassium, phosphorous, and iron. The high copper component in *P. armeniaca* plays a vital role in up to 50 different metabolic enzyme reactions in the body.[3] The nutritional value of the plant is summarized in Table 1.

Traditional and Ethnomedicinal Importance

In the folklore medicinal system, various parts of apricot are reported to treat a variety of ailments leprosy, cough, leukoderma, asthma, and nausea. The kernel part is used as a carminative to treat indignation, gastritis, ulcer, dermatitis, and other inflammatory disease. The seed oil has been used as a cosmetic ingredient since ancient times and is the main ingredient of skin exfoliating agents.[8] The oil extracted from its seeds has effective in the treatment of skin irritation, vaginal infection, acne vulgaris, and furuncle-like skin diseases. The kernels are also being used in Chinese medicine for cough, constipation, and asthma. The seeds of *P.armeniaca* are a key component of some traditional Chinese preparations that are used during the COVID-19 pandemic asadjuvant with another

Table 1: The nutritional composition of *P. armeniaca*

Nutritional Value	*Value*	*Minerals*	*Quality (mg)*	*Vitamins*	*Quality*
Energy	1009 Kj (241Kcal)	Calcium	55	Vitamins A	180 µg
Carbohydrates	63 gm	Iron	2.66	Thiamine B_1	0.015 mg
Sugars	53 gm	Magnesium	32	Riboflavin B_2	0.074 mg
Dietary fibre	7 gm	Phosphorous	0.235	Niacin B_3	2.589 mg
Fat	0.3	potassium	71	Pantothenic acid B_5	0.516 mg
Protein	3.4			Vitamins B_6	0.143 mg
				Vitamins C	1 mg
				Vitamins E	4.33 mg

potent medicine. The name of Chinesemedicinal preparations are available in the market with the names Lianhua Qingwen Capsules, Huashi Baidu Formula, and Xuanfei Baidu, which contain *P. Armeniaca.*[9]

P. armeniaca seed is widely used to treat common colds, coughs, and phlegm In Korea, treats digestive and respiratory disorders in Vietnam, and is used for pyelonephritis, prostate enlargement, and cancer treatment in Algeria. Amygdalin found in seeds possesses analgesic, expectorant, asthmatic, antitussive, spasmolytic, demulcent, emollient, sedative, and laxative properties. In Russia, a very small dose of amygdalin is used to prevent and treat cough, asthma, hypertension, constipation, migraine, and tumors. The roots are useful in the treatment of respiratory diseases like cough, bronchitis, and asthma, while the flowers help to promote women's fertility. In India, they are used to treat vomiting diarrhea, fever, parasitic infections, etc. The paste of seed with water is used to treat skin rashes. A combination of peach, apricot, and walnut seeds is used to treat bronchitis, respiratory tract infections, asthma, pulmonary tuberculosis, etc. This information provides a sufficient source to attract the scientific community to explore its unhidden application in health care as well as investigate for scientific justification of existing knowledge.[8,10]

Therapeutic Importance

Neuroprotective

A plant is reported as neuroprotective in Alzheimer's disease, which are age-associated neurological disorder causing impairments and loss of memory. The pathogenesis of Alzheimer's disease includes elements together with reduced acetylcholine levels, aberrant phosphorylation of tau protein, amyloid beta aggregation, and oxidative stress. Cholinesterase enzymes, which include acetylcholinesterase and butyrylcholinesterase, play a function in the breakdown of acetylcholine in the brain. Inhibition of those enzymes is a promising healing approach to prevent acetylcholine breakdown and enhance cognitive function. Current FDA-authorised medicines for Alzheimer's disease awareness frequently on symptomatic remedy and feature obstacles in phrases of efficacy and facet effects. The nutritive fruits of *P. armeniaca* is produced worldwide and has both sweet and bitter stones. The kernel part of fruit possesses various medicinal benefits, including neuroprotective activities. The plant kernel extract showed cholinesterase enzyme inhibitory properties. The investigator reported that sweet as well as Bitter-type aqueous extracts extracted from plants but bitter extract had the highest acetylcholinesterase inhibitory activity and neuroprotective properties. *P. armeniaca* kernels may help treat Alzheimer's disease and memory loss. According tostudies, apricot kernels may help decrease illness progression. Studies have shown that apricot kernels, particularly the bitter kind, can block cholinesterase enzymes and give neuroprotective benefits. More study into medicinal plants andherbal compounds is required for the development of effectiveanti-AD therapies.[11]

Anticancer activity

A specific indigenous apricot Japanese variety called Ume showed remarkable anti-tumor activity against hepatocellular carcinoma cells in a laboratory trial. Amygdalin is the most investigated phytoconstituent optioned in apricot in the treatment of cancer, capable of inducing apoptosis in a programmed manner and cancer cell edition specific to breast cell line MCF-7 and MDA-MB 231. Amygdalin is capable of increasing the level of pro-apoptosis and decreasing the anti-Pro apoptosis protein markers. A BAX and caspase-3 activity increases by amygdalin and decreases the BCL2 protein level. Amygdalin suppresses the proliferation of cell division by arresting the Cell cycle in the G-1 and sub-G-1 Phases. Total glutathione levels play an important role in the management of breast cancer. Amygdalin is capable of reducing total glutathione levels and the activity of glutathione reductase in breast cancer cells. All these findings suggest that anticancer effects are reported via multiple mechanisms, including induction of apoptosis, cell cycle arrest, inhibition of migration, and modulation of oxidative stress pathways. The ability of amygdalin to target different aspects of cancer cell survival and proliferation makes it a promising compound for further investigation as a potential therapeutic agent in breast cancer treatment.[12]

Phytochemicals

P. armeniaca is a delicious seasonal fruit famous for its nutritional beatifies worldwide. Natural components found in this plant have positive effects on health. Carotenoids (β -carotene), are a precursor to vitamin A well reported as having antioxidant benefits. Flavonoids present in *P. armeniaca* possess both antimicrobial and antioxidant effects. Glycosides are bioactive compounds mainly found in such as leaves, fruits, roots, and kernels, which exhibit cytotoxicity, anti-inflammatory, and antioxidant activity. The formation of phytochemicals in various parts of the plant depends on some factors like the variety of fruit, ripeness, and growing condition.[4,13] A variety of chemical constituents are found in this plant the list of phytochemicals found in *P. armeniaca* is tabulated in Table 2.

Adopted Nanotechnological Approaches

Nanotechnology encompasses scientific disciplines, including chemistry, physics, electronics, and biotechnology. In nanotechnology, the substance is converted into atomic, molecular, and supramolecular levels, having particle sizes of approximately 1 to 100 nm.[14] The useof nanotechnology allows easy access to technological advancements and the latest equipment. With its use, revolutionary changes are expected in the lives of common people. It has started making positive interference in human lives. There are more possibilities ahead. It has been utilized in the production of medical treatment, biotransformation, solarenergy, electronic devices, and food products. Its small size and ability to provide treatment at specific places in the bodyare going to bring a revolution in the medical field.[15] It is easy for it to find cancer cells among the manycells in the body. Due to its ability to reach the diseased parts ofthe body directly and accurately, one can get rid of the problemof side effects of medicines.[16] Presently, side effects of medicines occur because the medicines dissolve in the blood or reach the sick part of the body through other means and treat it. Nanoparticles are capable of enhancing drug efficacy and safety. P. *armeniaca* extract was tested loading in gold and silver nanoparticles to improve their antibacterial, antinociceptive, and anti-inflammatory properties. Similarly, the activity of amygdalin-folic acid nanoparticles is reported here.[17]

Development of Gold and Silver Nanoparticles

Gold and silver nanoparticles are well-adopted carrier systems for the delivery of phytoconstituents. These nanoparticles loaded with plant extract were used to investigate antibacterial activity, antinociceptive, and anti-inflammatory effects in BALB/c mice using different specific experimental methods. Nanoparticles have been assessed using several approaches ultraviolet-visible spectroscopy for drug estimation, scanning electron microscopy for carrier characterization, and atomic absorption drug carrier interaction studies. Energy-dispersive X-ray spectroscopy, X-ray diffraction, and Fourier-transform infrared spectroscopy are also adopted in the characterizationof metal nanoparticles prepared with plant extract. A gum extracted and metal ion concentration is critical issued with time on the reaction temperature and the synthetic stabilityof nanoparticles in the preparation and performance of nanoparticle.

An investigator suggested that the best optimized, stable, and effective nanoparticle was prepared with 0.5% w/v gum extract, with a 3-molar solution of gold-silver. The investigator suggested that the best reaction temperature was 80°C with a reaction time of 4 hours. The size of the prepared nanoparticle was arranged at 10 to 40 nm and 5 to 30 nm, respectively, for gold and silver metal. The prepared nanoparticles showed anti-wrinkle properties in the acetic acid-induced model and also effective carrageenan-induced paw swelling. The prepared formulation is instability when subjected to variable salt concentration, pH, and high temperature. The nanoparticles were capable of producing antibacterial, antinociceptive, and anti-inflammatory properties. The production of nanoparticles via plants is economical cheaper, ecologically friendly, and suitable for medicinal purposes. Water-soluble and physiologically active components that are poorly absorbed in their natural state obtained from plant extract attract more research in the same direction.[18]

Finally, the aqueous colloidal solution was produced, which contained gold and silver nanoparticles loaded with plant extract. The presence of the nanoparticle was confirmed by two methods first is UV spectroscopy and another by the emergence of ruby red and light-yellow colors production after heating for an hour in a plasma resonance study. A characteristic peak for gold nanoparticles and silver nanoparticles appeared at 550 and 450 nm, respectively. This study indicates about successful biogenesis of these two metals. Fourier transform infrared spectra of gum extracts and biosynthesized gold and silver nanoparticles showed that hydroxyl groups participated in the reduction and capping processes, and carboxylic acid groups participated as both reducing and capping agents. The Fourier transform infrared spectra of the biosynthesized gold and silver nanoparticles were identical, indicating that the metals had been reduced and that hydroxyl and carbonyl groups had played a stabilizing role.

The nanoparticles' homogeneous size distribution indicates effective immobilization. However, a few of them had greater sizes and/or anisotropic forms, maybe as a result of smaller nanoparticles aggregating. By using X-ray diffraction analysis, it was shown that metal cations are reduced to their elemental form, and pure crystalline gold and silver nanoparticles and face-centred cubic metallic gold phase gold and silver nanoparticles are used to produce high-purity products.[18]

Antibacterial Activity Assessment of Gold and Silver Nanoparticles

The zone of inhibition method has investigated the antibacterial activity of gold and silver nanoparticles over the bacterial *culture S. aureus, E. coli*, and *P. aeruginosa* in the conventional diffusion method, and inhibition of growth was noticed in gold and silver nanoparticle-treated cultures. However, the response of the test sample was less effective compared to positive control plates. In the study, streptomycin antibiotic discs were taken as a reference which exhibited larger inhibition zones. A recorded zone of inhibition for bacterial strains *S. aureus*,

Table 2: Chemical Constituents obtained from apricot plat are summarized with this biological activity

Source	Compound	CAS Number	Biological Activity	References
Leaf	3-*O*-Caffeoylquinic acid	906-33-2	Acetylcholinesterase (AChE) and Butyl-cholinesterase (BChE) Inhibitory Activity, antioxidant	(Wojdyło & Nowicka, 2021)
	Caffeoyl-glucoside	-	Anti-inflammatory	
	Quercetin-3-*O*-rutinoside	*30311-61-6*	Antioxidant	
	Quercetin-3-*O*-galactoside	482-36-0	Antioxidant	
	4-O-caffeoylquinic acid	905-99-7	Antioxidant, anti-inflammatory	
	3-*p*-Coumaroyl-quinic acid	*1899-30-5*	Antioxidant, anti-inflammatory	
	5-*O*-Caffeoylquinic acid	906-33-2	Antioxidant, anti-inflammatory	
	p-Coumaroyl-glucoside	-	Antioxidant	
	4-*O*-feruloylquinic acid	*2613-86-7*	Antioxidant	
	Kaempferol-3-*O*-rutinoside	17650-84-9	Antioxidant	
	Procyanidin	4852-22-6	Antioxidant	
	Feruloyl-glucoside	-	Anti-inflammatory	
Dry apricot fruit	Sorbitol	000050-70-4	Food and pharmaceutical industry	(Sharma, S. *et al.*, 2014)
	n-hexadecanoic acid	000057-10-3	Foaming agent	
	Hexadecanoic acid ethyl ester	000628-97-7	Flavoring agent, antioxidant	
Dry apricot fruit	10,13octadecadienoic acid, methyl ester	056554-62-2	Anti-inflammatory, anticancer	Sharma, S. *et al.*, 2014. (Krishnamoorthy & Subramaniam, 2014; Sharma, 2014) Krishnamoorthy K, *et al.*, 2014
Fruit	4′,5,7-trihydroxy flavone-7-O-[β-D-mannopyranosyl (l‴→2″)]-β-D-allopyranoside	-	Antimicrobial	Rashid. F. *et al.*, 2007(Rashid *et al.*, 2007)
	3,4′,5,7-tetrahydroxy3′,5′-di-methoxy flavone 3-O-[α-L-rhamnopyranosyl (l‴→6″)]-β-D-galactopyranoside	-		
Fruit	(R)-γ-decalactone	706-14-9	Odorant	Greger, V., & Schieberle, P. (2007). (Greger & Schieberle, 2007)
	(E)-β-damascenone	23696-85-7		
	δ-decalactone	705-86-2		
	(R/S)-linalool	78-70-6		
	epiafzelechin-3-O-phydroxybenzoate-(4α→8, 2α→O→7)-epiafzelechin	*101339-37-1*		Rawat, M.S.M., *et al.* 1999 (Rawat *et al.*, 1999)
	ent-epiafzelechin-(4α→8, 2α→O→7)-(+)-afzelechin	-		
	ent-epiafzelechin-(4α→8, 2α→O→)-(−)-afzelechin	-		
Leaves and fruit	Kaempferol	520-18-3		Henning, W. *et al.* 1980 (Henning & Herrmann, 1980)
	Quercetin	117-39-5		
	Rutin	153-18-4		

Cont....

Source	Compound	CAS Number	Biological Activity	References
Root	4-*O*-glycosyloxy-2-hydroxy-6-methoxy acetophenone	*703-23-1*		Prasad, D. 1999
Kernel seeds	Amygdalin	29883-15-6	Antiproliferation and cytotoxicity	Kitic, D., *et al.* 2022
Fruit	4 aminobenzoic acid	*150-13-0*	Antioxidant	Gottingerova, M., *et al.* 2023
	Chlorogenic acid	327-97-9		
	Cinnamic acid	140-10-3		
	Catechin	154-23-4		
	Epicatechin	490-46-0		
	Quercitrin	522-12-3		
	Quercetin	117-39-5		
	Transpiceid	-		
	Quercetin-3-b-d-glukosid	-		
	Phloridzin	60-81-1		
Dry apricot fruit	4H-pyran-4-one,2,3-dihydroxy-3,5-dihydroxy-6-methyl	028564-83-2	Antimicrobial, Anti-inflammatory	Sharma, S. *et al.*, 2014. V. Eugin amala *et al.*, 2014
	2-furan carboxaldehyde, 5-(hydroxymethyl)	000067-47-0	Antimicrobial, Preservative	
Dry apricot fruit	1,2-benzenediol,3-methyl	0000488-17-5		Sharma, S. *et al.*, 2014.
Fruit juice	Limonene, α (E,E)-farnesene	-	Flavor, aroma	Riu, M. *et al.*,2004
Dry apricot fruit	2-Furanemethanol	000098-00-0		Sharma, S. *et al.*, 2014
	Hydroquinene	000123-31-9	skin whitening effect	
Fruit juice	linalool	-	Flavor, aroma	Riu, M. *et al.*,2004
	α-terpinolene	-	Flavor, aroma	
	megastigma-4,6,8-triene	-	Flavor, aroma	
Dry apricot fruit	Isosorbide	000652-67-5	Treatment for coronary diseases	Sharma, S. *et al.*, 2014.
Dry apricot fruit	2-methoxy-4-vinyl phenol	007786-61-0	Antimicrobial, antioxidant, anti-inflammatory, analgesic, anti-germination	Sharma, S. *et al.*, 2014. Rubab, M. *et al.*, 2020
Dry apricot fruit	L-glutamic acid	000056-86-0	Works as a neurotransmitter	
	Propylamine, N-[9-borabicyclo [3.3.1] non-9-yl]	1000160-82-3	Cosmetic and food industry	
	Hexadecanoic acid methyl ester	000112-39-0	Antibacterial, cosmetic industry	

Cont....

Source	Compound	CAS Number	Biological Activity	References
Dry apricot fruit	9-octadecanoic acid (Z)-, methyl ester	000112-62-9	Anti-inflammatory, antiandrogenic cancer preventive, anemia genic, insectifuge, 5-alpha reductase inhibitor, dermatitigenic hypocholesterolemia,	Sharma, S. *et al.*, 2014. Krishnamoorthy K, *et al.*, 2014
	Octadecanoic acid, methyl ester	000112-61-8	Anti-inflammatory, antiandrogenic cancer preventive, irritant, anemia genic, 5-alpha reductase inhibitor, dermatitigenic, flavor, insectifuge	
Dry apricot fruit	Oleic acid	000112-80-1	Emollient, Anti-inflammatory, Anticancer, wound healing properties, enhance immunity, treat autoimmune diseases	Sharma, S. *et al.*, 2014. Sales-Campos et. al., 2013
Fruit	gamma-Sitosterol	000083-47-6	Anticancer, antidiabetic	Sharma, S. *et al.*, 2014.(Sundarraj *et al.*, 2012) (Sirikhansaeng *et al.*, 2017)
Fruit	Stigmasterol	000083-48-7		Sharma, S. *et al.*, 2014.
	Nonanoic acid,9-(3-hexenylidenecyclopropylidene)-,2-hydroxy-1-(hydroxymethyl)ethylester,(Z,Z,Z)	055268-58-1		
	Octadecanoic acid	000057-11-4		
Fruit	9,17-octadecadienal, (z)	056554-35-9	Antimicrobial	Sharma, S. *et al.*, 2014. Krishnamoorthy K, *et al.*, 2014
	9,12-octadecadienoic acid(z,z)	000060-33-3	Anti-inflammatory, hepatoprotective, anticancer, insectifuge, antiarthritic, nematicide, antieczemic, antiandrogenic, hypercholesterolemic	
Fruit	Octadec-9-enoicacid	10000190-13-7		Sharma, S. *et al.*, 2014.
	Cyclopropaneoctonal,2-octyle	056196-06-6		
	1-eicosene	003452-07-1		
	Hexadecanoic acid, 2-hydroxy-1-(hydroxymethyl)ethylediester	023470-00-0		
Seed	Phenols	108-95-2	Antioxidant, anti-inflammatory, antibacterial, antifungal, anticancer, antiviral, vaso-protective, and anti-allergic	(Spanoudaki *et al.*, 2023)
	β-carotene	7235-40-7		
	Tocopherols	1 0191-41-0		

E. coli, and *P. aeruginosa* for gold and silver nanoparticles were 10 ± 0.3, 9 ± 0.5, 7.9 ± 0.3, and 18 ± 0.5, 10.2 ± 0.8, & 11.2 ± 0.3 mm, respectively. The silver nanoparticles exhibited a higher antibacterial effect than gold nanoparticles. Since there was no antibacterial activity in the gum extract, the bactericidal activity could be attributed to the synergistic action of gum-stabilized gold and silver nanoparticles, as well as unreduced Au (III) and Ag+ ions. There was a greater zone of inhibition in gram-positive bacteria (*S. aureus*) compared to gram-negative strains (*E. coli, P. auginosa*). In the same experimental setup, *Streptomycin* produced a zone of inhibition 22.5 ± 0.5 mm, 20.2 ± 0.3 mm, and 15 ± 0.5 mm for *S. aureus*, *E. coli*, and *P. aerug*i, respectively.[18]

Antinociceptive Activity Assessment of Gold and Silver Nanoparticles

The antinociceptive effect was studied in acetic acid-induced nociception rats modal. The gum extract was effective at a dose of 200 and 400 mg/kg, while gold nanoparticles were effective at doses of gold 40 and 80 mg/kg. In this study, diclofenac sodium as a reference compound also produced nociception at a dose of 50 mg/kg. The investigator concludedthat a low dose of gold nanoparticles showed similar effects asa high dose of gum extract.[18] A significant level of Gum extract of *P. armeniaca* nociceptive effects was(P <0.001); Similarly, gold nanoparticles effectively reduced acetic acid-induced nociception at dosages of 40 mg/kg ($p < 0.01$) and 80 mg/kg ($p < 0.001$).

Anti-inflammatory Activity Assessment of Gold and Silver Nanoparticles

An investigator studied the anti-inflammatory impact of carrageenan-induced paw edema in rats by determining paw volume with a digital plethysmometer. The gum extract and gold nanoparticles reduced carrageenan-induced inflammation in mice paws in a highly effective and prolonged manner. Both the gum extract and gold nanoparticle had an anti-inflammatory effect at significantly lower doses (40 and 80 mg/kg) and (200 and 400 mg/kg), respectively. Both were effective compared to standard diclofenac sodium. The carrageenan-induced inflammation model is considered as good because of the contribution of various mediators like histamine, serotonin, and bradykinin on vascular permeability in inflammation induction.[18]

Anticancer Activity Assessment of Amygdalin-folic Acid Nanoparticles

Amygdalin an active constituent of apricot, is ~~well~~ well-known chemical used worldwide for the treatment of different types of cancer cell lines. The range of effectiveness includes lung, prostate, brain cancer, and breast cancer line, etc. The investigator prepared and assessed the efficacy of amygdalin-folic acid nanoparticles in the treatment of breast cancer cell lines breast cancer lines MCF-7 and MDA-MB-231. The formation of amygdalin-folic acid nanoparticles demonstrated tremendous therapeutic potential in breast cancer lines MCF-7 and MDA-MB-231. The formation of nanoparticles involves several steps. In brief, the amygdalin aqueous solution is prepared through sonication at 25˚C. In another vial, folic acid and dimethyl sulfoxide were mixed and placed. Then, the folic acid solution was added to the amygdalin solution. After that, the mixture was left to dry in an oven set at 80°C and finally filtered the solution with suitable filtration techniques. The resulting nanoparticles were preserved at room temperature.[31]

Nanoparticles exhibited sustained releasing characteristics and selectivity in uptake for breast cancer cell lines. The amygdalin-folic acid nanoparticles selectively suppress the growth of cancer cells apoptosis. Same time decreased breast cancer proliferation by down-regulating mitogen-activated protein kinases (MAPK/P38), iron, nitric oxide, and up-regulating reactive oxygen species. Amygdalin-folic acid nanoparticles have also been demonstrated to decrease the expression of the cluster of differentiation (CD4, CD80), a marker compound in cell apoptosis. A prepared nanoparticle obstructs the suppression in the proliferative signalling hub caused by transforming growth factor beta (TGF-β), interferon-gamma (INF-g), interleukin-2 (IL-2)/interleukin-6 (IL-6), and vascular endothelial growth factor (VEGF). Another noticeable point is folate nanoparticles with plant extract increasing the expression of CD8 and natural killer group 2D receptor (NKG2D). [31]

Toxicity Concern

Scientifically published as well as traditional practice reports regarding *P. armeniaca* provide significant data regardingthe toxicity aspect of this plant. The seeds of *P.armeniaca* contain a toxic compound, amygdalin, well reported in the literature.[32] In the oral acute toxicological study, about 2000 mg/kg of pre-brewed *P. armeniaca* semen,which contains amygdalin, caused the death of either sex rat just after two hours of oral treatment. The toxicological signsassociated with increases in heart rate and respiration, loss of locomotion, seizures, etc. The LD_{50} of amygdalin in both male and female rats was found to be equal to 9279.5 mg/kg.[33-34]

Allergy

P. armeniaca seed proteins can cause allergies by interacting with and binding to IgE (Kitic *et al.*, 2022b). Pru ar 1 and Pru ar 3 are two allergic proteins found in P. *armeniaca.* Pru ar 1 is involved in immunoglobin E (Ig E) cross-reactive allergies to birch pollen and it is likely to be a Bet v 1 pathogenesis-related protein that plays a role in plant defense against insect, pest, and microbial diseases. This Bet v 1 appears to be the sensitizing agent in most cases. Swelling of lips, Sore throat, itchy mouth, tongue, mouth, throat, and hives on the mouth are common symptoms of allergy reported by *P. armeniaca,*which is considered as ″oral-fruit syndrome″ responsible dueto Birch pollen allergic reaction.[35]

Pru ar 3 is a lipid transfer protein a non-specific type allergen protein that is resistant to heat denaturation and found mostly in fruit's pericarp with less amount in fruit pulp. Immunoglobin E to Pru ar 3 cross-reacts with lipid transfer protein from other prunoideae, including plum, peach, cherry, etc. The role of immunoglobin E binding to non-specific lipid transfer protein from certain pollens has been still clear to date by the symptomatic relationship implicated in the response.[36-37]

Cyanide Poisoning

The cyanide poisoning induced by *P. armeniaca* kernel intake has been recorded. Massive and rapid exposure to cyanogenic glycosides can cause mental confusion, dizziness, diarrhea, nausea, vomiting, convulsions, weakness, coma, and death.

This effect is produced due to hydrogen cyanide inhibiting cellular respiration by limiting mitochondrial electron transport and preventing oxygen intake. Cyanides can be eliminated from the body by the urethra route. In this process, thiosulfate sulfur-transferase is involved in the detoxification process. , Finally transforms them into thiocyanates, and eliminated in the urine. Amygdaline [D- mandelonitrile-B-D- glycoside] is a biomolecule that belongs to the cyanogenic glycoside category, mainly found in *P. armeniaca* seeds. According to a case study that was conducted in Turkey between 2005 and 2009, 13 patients with cyanide intoxication were admitted to the Pediatric Intensive Care Unit of Erciyes University. Most of the cases of cyanogenic intoxication were associated with the ingestion of *P. armeniaca* seeds by children. They found the initial symptoms related to oral cyanide poisoning developed within 30 minutes to 2 hours after ingestion. It mainly includes headache, vomiting, abdominal pain, irritability, dyspnea, dizziness, etc. The advanced clinical symptoms of cyanide intoxication, such as seizures, pulmonary edema, hypotension, and coma, were reported. Another case of cyanide intoxication in a 3-year-old boy was reported in Algeria, a country in North Africa. The patient was admitted to a pediatric unit after ingestion of 8 to 12 apricot seeds (The overall amount of cyanide consumed is predicted to be between 9.25 and 13.87 mg). After ingestion of seeds, the patient faced loss of consciousness associated with convulsive activity.[38]

Amygdaline-related poisoning was reported in an Arabic 73-year-old woman, prescribed amygdaline to treat pancreatic cancer with 500 mg tablets. Amygdaline is considered a naturally occurring anticancer compound that could help to stop the spread of cancer. On the first day of administration, she took three tablets as per prescription by her physician. She experienced some unusual symptoms like changes in mental status & disorientation, diaphoresis, tachycardia, vomiting, and campy stomach pain 45 minutes later of the administration of tablets. Physicians and pharmacists studied and case by calculating the dose consumed by the patient, e.g., 1500 mg of amygdalin, which contains around 90 mg of cyanide. The noticeable point is the minimum lethal dose of cyanide is 50 mg, but the patient consumed approximately 1.8 times more cyanide. However rapid identification of clinical signs of toxicity and aggressive medical care can improve survival in patients.[38-39]

Apricot in Pregnancy

The fruit of *P. armeniaca* is generally considered healthy during pregnancy. The reason is that the fruit contains protein, fiber, folate, calcium, iron, zinc, etc. are essential during pregnancy. Along with this, the pregnant woman also needs vitamins A, B, C, and E for better development of the fetus,

P. armeniaca contains all these essential nutrients. The fruit is safe but the kernel part of *P. armeniaca* is reported unsafe to consume during pregnancy and breast-feeding due to the presence of cyanogenic glycoside. Cyanide is a potent toxin that can harm the fetus and mother. Amygdaline is a cyanogenic glycoside responsible for cyanide toxicity in pregnant women and lactating mothers. Cyanide enters the bloodstream immediately after exposure. Small levels of cyanide are handled differently by the body than high amounts. In the biotransformation process of cyanide, a less toxic compound, thiocyanate, is generated, which is eliminated through urine. In very small doses, cyanide is involved in the generation process of vitamin B_{12}. This process helps in the maintenance of healthy neurons and red blood cells. Cyanide in high concentrations prevents cells from using oxygen, causing them to die. Cyanide poisoning is especially hazardous to the heart, respiratory system, and central nervous system. In Mexico and the United States, the marketed formulation of amygdalin, an alternative cancer drug, is not recommended in pregnant and lactating mothers due to the potential risk of birth defects. Exposure to cyanide and thiocyanate during pregnancy leads to thyroid disease in the fetus.[38-39]

CONCLUSION

The medicinal importance of any natural source purely depends upon the chemical constituents present inside the source. *P. armeniaca* has a variety of chemical constituents used for various purposes but still needs to explore more applications in medical science. A balance between therapeutic and toxicity is important for the applicability of any natural source. Allergic to specific races, childbirth defects, and cyanide-like poisonings are found by administration of raw fruit material. These issues provide a dimension of study, the need for precision in extraction isolation, deliver for medicinal use of its active ingredient. A nanotechnological concept can take this task by modifying and tailoring a delivery system. The present review correlates and links above three dimensions of the study.

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