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Prunus domestica: a review

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Abstract: *Prunus domestica ,* the European plum, probably originated from South-Eastern Europe and South Western Asia and is cultivated in temperate zones throughout the world. The fruit of this plant is widely used for nutritive, laxative, and digestive properties. Different phenolic acids, quinic acids, flavonoids, and anthocyanins have been isolated from extracts of the plum. The fruit is documented to possess beneficial effects such as hypotensive, hypoglycemic, and hepatoprotective. A scrutiny of the literature revealed some notable pharmacological activities of the fruit such as antioxidant, antihyperlipidemic, anticancer, anti-osteoporosis, anxiolytic and antibacterial, memory improving characteristics. Phenolic acids, such as chlorogenic acids, anthocyanins, flavanols, flavonols, and coumarins are the main polyphenolic compounds present in plum. Phenolic compounds in foods act as antioxidants for low-density lipoprotein (LDL) therefore have been associated with reduced incidences of heart disease. Reports are not available for any toxicity or contraindication until now. The present review is an attempt to highlight the chemical constituents, their mechanism of action, and various pharmacological reports on *Prunus domestica.*

پرونس ڈومیسٹیکا ، یوروپی بیر ، ممکنہ طور پر جنوب مشرقی یورپ اور جنوبی مغربی ایشیاء سے شروع ہوا تھا اور پوری دنیا کے تپش والے خطوں میں کاشت کیا جاتا ہے .اس پودے کے پھل کو وسیع پیمانے پر غذائیت ، جلاب اور عمل ، انہضام کی خصوصیات کے لئے استعمال کیا جاتا ہے۔ پلم کے نچوڑ سے مختلف فینولک ایسڈ ، کوئینک ایسڈ فلاوونائڈز اور انتھوکائینن الگ کردیئے گئے ہیں۔پھل کو کچھ مفید اثرات رکھنے کے دستاویزی حیثیت دی گئی ہے جیسے ہائپوٹینشل ، ہائپوگلیسیمک اور ہیپاٹروپیکٹیو۔ ادب کی جانچ پڑتال سے پھلوں کی کچھ قابل ذکرادویاتی ، سرگرمیوں کا انکشاف ہوا جیسے اینٹی آکسیڈینٹ ، اینٹی ہائپرلیپیڈیمک ، اینٹینسیسر ، اینٹی آسٹیوپوروسس ، اینسیوالیٹک اور اینٹی بیکٹیریل ، میموری کو بہتر بنانے کی خصوصیات۔ فینولک ایسڈ ، جیسے کلورجینک تیزاب انتھوکیانینز ، فلاونولز ، فلاونولس ، اور کومرنس ، بیر میں موجود اہم پولیفینولک مرکبات ہیں۔ کھانے کی چیزوں میں فینولک مرکبات کم کثافت لیپو پروٹین)ایل ڈی ایل (کے لئے اینٹی آکسیڈینٹ کے طور پر کام کرتے ہیں لہذا اس سے دل کی بیماری کے واقعات میں کمی واقع ہوئی ہے۔ابھی تک کسی بھی قسم کی زہریلےاثر کے لئے رپورٹس دستیاب نہیں ہیں۔ موجودہ جائزہ کیمیائی اجزاء ، ان کے عمل کے طریقہ کار اور پرونس ڈومیسٹیکا سے متعلق مختلف دوا ساز رپورٹوں کو اجاگر کرنے کی کوشش ہے۔

Keywords: *Prunus domestica ,* plums, polyphenols, antioxidants, laxative

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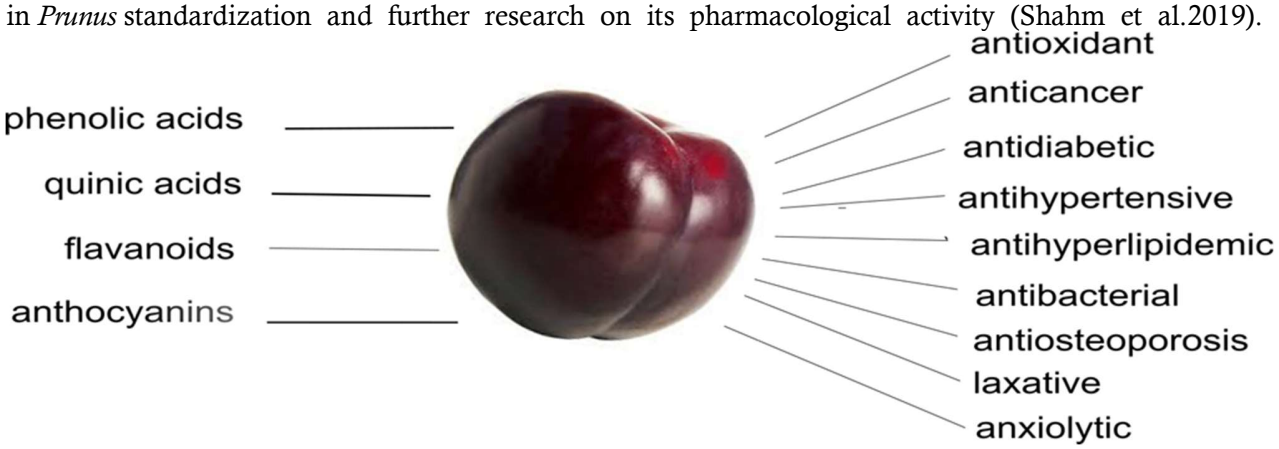
Prunus domestica is a valuable plant belonging to the family *Rosacea* and widely distributed around the world. Trees are medium-sized with ovate or elliptical leaves, small flowers, and fleshy oval fruits. Its fruit is consumed as food or medicine in either fresh or dried form. These are commonly known as plums and prunes. These fruits possess medicinal values. Consumption of fruits like these is helpful in blood circulation problems, measles, and digestive problems (Ahmed et al. 2010). Prunes are a significant source of major nutrients like carbohydrates, amino acids, vitamin A, Vitamin B complex, potassium, calcium, magnesium, and dietary fiber. The total dietary fiber increases by the process of drying (Siddiq 2006). A Total of 12 polyphenolic compounds identified in plum juice powder are 3 anthocyanins, 4 flavanols, and 5 phenolic acids. The antioxidant properties of plum can be attributed to these high amounts of polyphenols present in it (Michalska et al. 2017). The Five phenolic substances include three hydroxycinnamic acids, gallic acid, and rutin. Neochlorogenic acid (2320±42 mg/kg) was found as the dominant substance. Identification of phenolic substances was performed in the extract and their amount was determined using High-Pressure Liquid Chromatography (HPLC) (Shahm et al. 2019). Prunes have been found to possess laxative activity by increasing the motility of the gastrointestinal tract. Consumption of prune is beneficial in diabetes because it does not immediately raise the level of blood glucose (Stacewicz et al. 2001). It has shown anticancer activity because of having a cytotoxic effect on the growth of 3 tested cancer cell lines (Miljić et al. 2016) recent studies have suggested that the anticancer activity of prunes can be attributed to its polyphenolic contents and antioxidant activity. Plums and prunes are safe to consume and there are no reports of adverse effects. Paper Chromatography (PC), Thin Layer Chromatography (TLC), and High-Pressure Liquid Chromatography (HPLC) methods were used to study the chemical composition of *Prunus*. The prospects of creating a new agent with hypouricemic, membrane-stabilizing effects were proven. The results obtained will be further utilized in *Prunus* standardization and further research on its pharmacological activity (Shahm et al.2019).



Distribution: Humans have been manipulating the plum since ancient times, and the true origin of the plant is still partially unknown. Nevertheless, it is assumed to have originated in south-Eastern Europe (Caucasus) and southwestern Asia. In the Canaries, as well as being widely cultivated on almost all the islands, it has also become established in the wild on Tenerife and Gran Canaria. Pakistan,
West Asia to Europe.

Botanical description: The plum is a medium-sized tree that grows to a maximum of 6 m tall, bearing straight branches and a greyish-brown trunk that is shiny and smooth or somewhat split. This tree is not commonly thorny, but some plants that have shifted to the wild may have thorny twigs. The leaves are simple, deciduous, and alternate, and are sometimes form clusters on short shoots. They are elliptical or inversely ovate with a serrated or crenate margin. These are usually hairless and 4-8cm long. Flowers having 5 white petals are hermaphroditic and increase in small groups of 2 or 3 flowers on long stalks. They are 1.5-4 cm in diameter when open. The plums ripen quickly at the end of summer and are fleshy, round, or elongated in shape. These are available in a variety of colors from yellow to blackish purple. It

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encloses a single hard, flattened stone that has a seed inside, and its skin is almost always coated with a whitish waxy layer (Bloom). The time for seed ripening is from July to November. The flowers are pollinated by insects. It is a self-fertile plant (www.arbolappcanarias.es/prunus-domestica).

Cultivation: Plum requires a well-drained moisture-retentive and loamy soil and a sheltered position. Fruits are better in a sunny position.it prefers heavy clay soils and chalks in the soil but it is likely to become chlorite if it is present in abundance. The plant grows well at a pH between 6 and 6.5. The plum is broadly cultivated in temperate regions. Sunny south or west-facing wall is much suitable for most of the cultivars. Most of the members belonging to this genus are shallow-rooted and develop suckers if the roots become damaged. Plants in this genus are potential hosts for honey fungus (Usmanghani K et al. 2007).

Chemical Constituents: Different drying techniques were utilized for obtaining the plum juice powders containing polyphenolic compounds and the identification and quantification of these polyphenolic compounds was performed by Liquid chromatography-mass spectrometry QT of according to Ultraviolet-visible (UV/Vis) spectroscopy (UV/VIS spectra), Mass Spectrometry (MS), Tandem mass spectrometry (MS/MS), molecular ions [M − H]− and [M + H]+, and UPLC-PDA. A total of 12 polyphenolic compounds were identified which includes 5 polyphenols, 4 flavonols, and 3 anthocyanins (Michalska et al. 2017). Chlorogenic acids, neochlorogenic acid, and caffeic acid were found as the major phenolics present in plums (Jaiswal et al. 2013, Miletic et al. 2013)(Table 1 & Figure 1).

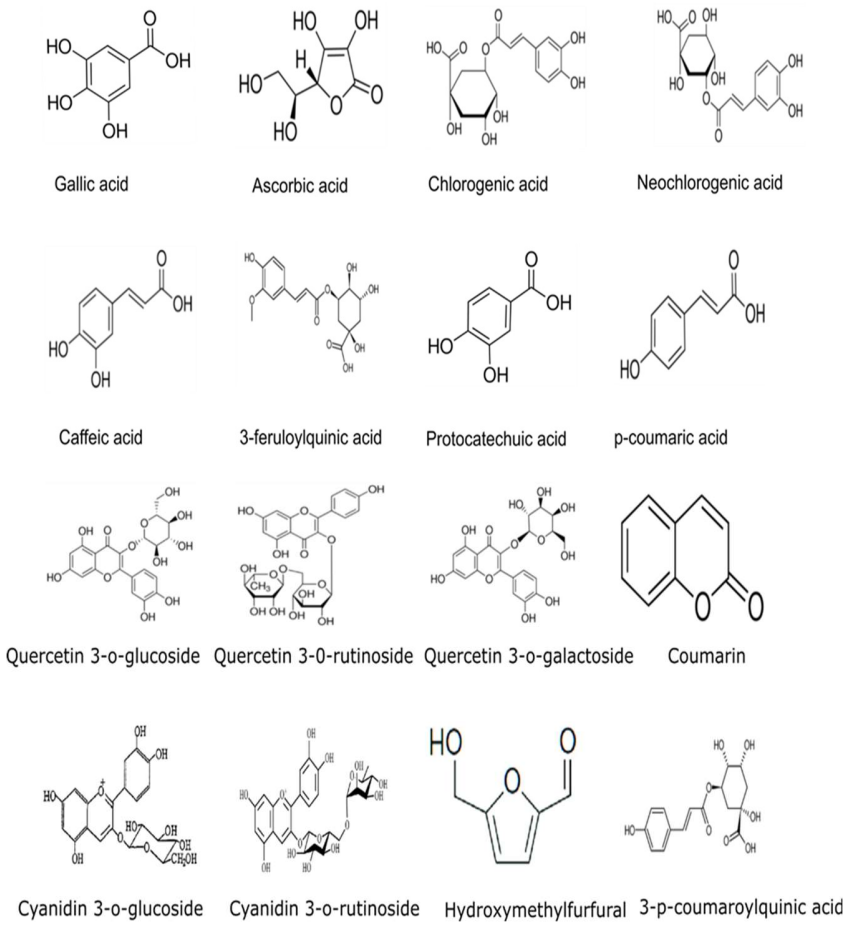

Figure 1: Chemical constituents of *Prunus domestica*

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Table 1: Chemical Constituents of *Prunus domestica*

S. NO	NAME	CLASS	PHARMACOLOGICAL ACTION
1	L-ascorbic acid (Michalska et al. 2017)	Monosaccharide organic acid	Antioxidant (Hamid et al. 2010)
2	Neochlorogenic acid (Michalska et al. 2017)	Phenolic acid	Neuroprotective effects (Kim et al. 2015)
3	3-p-coumaroylquinic acid (Michalska et al. 2017)	Phenolic acids	Not reported yet
4	Chlorogenic acid (Michalska et al. 2017)	Phenolic acids	Hepatoprotective effects (Naveed et al. 2018)
5	3-feruloylquinic acid (Michalska et al. 2017)	Quinic acid	Not reported yet
6	Methyl-3-caffeoylquinic (Michalska et al. 2017)	Quinic acid	Antioxidant (Hu et al. 2014)
7	Quercetin-3-o-glucoside (Michalska et al. 2017)	Flavonoid	Antidiabetic and antioxidative effects (Panda and Kar 2008)
8	Quercetin-3-o-rutinoside (Michalska et al. 2017)	Flavonoid	Anticancer (Sumanta et al. 2010)
9	Quercetin-3-o-galactoside (Michalska et al. 2017)	Flavonoid	Antibacterial activity (Waage and Hedin 1985)
10	Cyanidin 3-O-rutinoside (Michalska et al. 2017)	Anthocyanin	Antidiabetic (Adisakwattana et al. 2011)
11	Cyanidin-3-O-glucoside (Michalska et al. 2017)	Anthocyanin	Anti-allergic effect (Han et al. 2009)
12	Peonidin 3-o-rutinoside (Michalska et al. 2017)	Anthocyanin	Cardioprotective (Liobikas et al. 2016)
13	Coumarins (Michalska et al. 2017)	Benzopyrone	Antibacterial and anti tumor activity (Jain and Joshin2012)
14	Hydroxymethylfurfural (Michalska et al. 2017)	Furans	Cardiovascular effects (Wölkart et al. 2017)
15	Gallic acid (Mohammed et al. 2019)	Phenolic acid	Hepatoprotective (Anand et al. 1997)
16	Caffeic acid (Miletic et al. 2013)	Hydroxycinnamic acid	Anticancer activity against hepatocarcinoma (Aspindola et al. 2019)
17	Protocatechuic acid (Miletic et al. 2013)	Hydroxybenzoic acid	Antibacterial, anticancer and antioxidant activity (Khan et al. 2015)
18	Coumaric acid (Donovan et al. 1998)	Hydroxycinnamic acid	Antioxidant (Kiliç and Yesilog˘lu 2013)

Hypotensive activity: Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP), and Ambulatory Blood Pressure (MABP) was decreased in normotensive anesthetized rats when given intravenous administration of crude extract of *Prunus domestica* but it has a dose-dependent effect (Jabeen et al. 2012). *Prunus domestica* has been shown to modify the intracellular calcium concentration which results in negative ionotropic and chronotropic effects which could be responsible for lowering blood pressure. These cardioprotective effects may be attributed to the high levels of phenolic compounds present in *Prunus domestica* (Ahmed et al. 2018).

Antihyperlipidemic activity: Plum juice is shown to be associated with a higher abundance of intestinal microbiota especially lactobacillus when administered by obese animal models and this effect

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can be attributed to its antihyperlipidemic effect because obesity is thought to be related to reduced bacterial diversity (Noratto et al. 2014). When polyphenolic compounds were isolated from *Prunus domestica* red and yellow and tested *in-vitro* for antihyperlipidemic activity results showed that *Prunus domestica* red has a greater hyperlipidemic effect than *Prunus domestica* yellow (Roomi et al. 2013).

Anticancer activity: During the exploration of the multi-target therapeutic potential of *Prunus, Domestica* gum loaded nanoparticles in different *in vitro* and *in vivo* testing paradigms both the gold and silver nanoparticles were found to be the selective inhibitors of cancer cells (Nazar ul Islam et al. 2017). Plum wine has shown a significant cytotoxic effect on the growth of three tested cancer cell lines(Hep2c, RD, and L2OB)(Miljić et al. 2016). Chlorogenic acid has been demonstrated to exhibit the maximum antiproliferative activity on MDA-MB-468 human breast cancer cell line (Dhingra et al. 2013). A study was conducted to identify the phenolic fraction responsible for the potential chemopreventive and/or chemotherapeutic actions in plum. All extract fractions were found effective in exerting an antioxidant effect on studied cancer cell lines with the flavonols and procyanidins more effective than the phenolic acids and anthocyanins (Noratto et al. 2009).

Antioxidant activity: The phenolic compound in food usually acts as antioxidants for low-density lipoproteins. A major amount of cholinergic acid and noncholinergic acid were found when commercial prune and prune juice extracts were analyzed using reversed-phase HPLC with diode array detection and these compounds are responsible to inhibit the oxidation of low-density lipoprotein (LDL) (Donovan et al. 1998). Fresh samples of ethanolic and methanolic extracts of *Prunus domestica* have more antioxidant capacity than the dried one (Morabbi Najafabad and Jamei 2014). The 4-o-caffeoylquinic acid along with 28 other isolated compounds including coumarin, flavonoids, hydroxycinnamic acid, lignans, and benzoic acid have shown high antioxidant properties when measured by oxygen radical absorbance capacity (Kayano et al. 2004).

Anxiolytic activity: Chlorogenic acid, a polyphenol from *Prunus domestica* has been shown to cause the activation of benzodiazepine receptors at the dose of 20mg/kg thereby inducing a decrease in anxiety-related behaviors (Bouayed et al. 2007).

Hepatoprotective activity: Rutin has been known to target the initial phase of infection With the Hepatitis C virus (HCV) that is preventing the entry of HCV in hepatic cells significantly (~62%) by inhibiting the binding of labeled HCV-LPs to Huh 7 cells of the liver. It has proved to be nontoxic to hepatocytes even at high concentrations (Bose et al. 2017). A significant reduction in the level of serum alanine transaminase and serum alkaline phosphatase was reported in a clinical trial by 166 healthy human volunteers (Ahmed et al. 2010).

Effects on gastrointestinal tract: Upon administration of prune juice for 4 study weeks, a mild laxative effect was reported in adults with certain gastrointestinal symptoms however increase in flatulence was also observed (Piirainen et al. 2007). Oxyphenisetin, a reported constituent of prune, has been shown to act as a contact laxative (Ritchie 1972). After the consumption of yogurt containing galactooligosaccharides (12 g/day), prunes (12 g/day), and linseed (12 g/day), the severity of constipation was reduced in elderly subjects with mild constipation during a double-blind crossover study (Saarinen et al. 2007). The laxative effect was attributed to a synergistic effect provided by sorbitol, dietary fiber and polyphenols (Attaluri et al. 2011).

Antidiabetic activity: Purunusides A-C, new homoisoflavone glucosides, isolated from *Prunus domestica ,* has been reported as a potent inhibitor of enzyme alpha-glucosidase (Kosar et al. 2009). In alloxan-induced diabetic rats, the methanolic extract of *Prunus domestica* has shown significantly reduced the levels of blood glucose after 14 days of treatment (Nayudu and Sowjanya 2017).

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Bone density: Prunes are reported to be effective in preventing and reversing bone loss (Houshmand and Arjmandi 2009). In a randomized study, consumption of either 100g dried plums or 75g dried apples daily for 3 months, only dried plums significantly increased serum levels of insulin-like growth factor-I (IGF-I) and bone-specific alkaline phosphatase (BSAP) activity in menopausal women. Higher levels of both are associated with greater rates of bone formation (Arjmandi et al. 2002). Dried plums have been reported to be effective in restoring femoral and tibial and lumbar bone density osteopenic ovariectomized rats (Deyhim et al. 2005).

Antibacterial activity: When the antibacterial assay was performed for *Prunus domestica* using the diffusion method, the resultshowed that it affects both gram positive and negative bacteria equally. The best inhibition activityat the concentration of 10 µg/mL was found to be against Escherichia coli growth (Belhadj andMarzouki 2014). Ethyl acetate extract of *Prunus domestica* was reported to have the highest antibacterial activity while ethyl alcohol extract showed the least antibacterial activity during a screening of solvent dependent antibacterial activity using the agar well diffusion method (Yaqeen et al. 2013).

Effect on learning and memory: The hydroalcoholic extract of plum has shown a beneficial effect on the learning and memory of mice due to its antioxidant properties during the passive avoidance task (Shahidi et al. 2013; Shukitt et al. 2009).

Anti-inflammatory activity: The dry extract from *Prunus domestica* fruits containing fibers has been reported to show anti-cyclooxygenase, anti-lipoxygenase, and antioxidative properties (Seniuk and Sahlanee 2019).Dried plum polyphenols at a dose of 1000 µg/mL were found to be able to reduce the production the pro-inflammatory markers, nitric oxide (NO), and cyclooxygenase-2 (COX-2) inactivated macrophage RAW 264.7 cells, thus showed strong anti-inflammatory activity (Hooshmand et al. 2015; Silvan et al. 2020).

Toxicology: There are no toxicological reports available for *Prunus domestica* until now. The eatable portion is non-toxic and is safe to consume. Seeds contain cyanogenic glycosides; amygdalin and prunasin,which upon hydrolysis, release hydrogen cyanide however these glycosides don't seem to be hydrolyzed and remain enclosed in seeds until cells containing these glycosides are damaged (Vetter 2000). Improperly processed food containing plums can be a cause of cyanide poisoning if consumed (Vetter 2000).

Contraindications: Currently, no information or data is available for the contraindication of *Prunus domestica* but people allergic to the other plants in the Rosacea *family* may be allergic to plums too (Pastorello et al. 1994).Many people may avoid consuming plums because of the intestinal distress it causes however study suggests that administration of 100 g of dried plums daily does not cause significant changes in the bowel habits of post-menopausal women (Lucas et al. 2004).

CONCLUSION

The chemical, pharmacological and clinical studies reported in the present review shows the therapeutic value of *Prunus domestica*. It has been documented as anti-hypertensive, anti-hyperlipidemic, and anti-osteoporotic. The presence of different active chemical compounds such as chlorogenic acid, neochlorogenic acid, and caffeic indicates that this plant could serve as a lead for the development of the new drug in certain disorders in the coming years. In this regard, different human trials and further investigation should be done to evaluate its potential in preventing and treating diseases.

CONFLICTS OF INTERESTS

Authors have declared that no competing interests exist.

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