

A COMPREHENSIVE REVIEW ON SYZYGIUM CUMINI

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How to cite this Article: Afna Salim^{*1}, Akhina S.S^{*1}, Anuja Unni^{*1}, Goutham S Anand^{*1}, Dr. Arun T.S², Ms. Sariga Mohan³, Dr. Prasobh G.R⁴ (2026). A Comprehensive Review On Syzygium Cumini. World Journal of Pharmaceutical and Medical Research, 12(10), 54–59.

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Article Received on 21/08/2026

Article Revised on 11/09/2026

Article Published on 01/10/2026

ABSTRACT

Syzygium cumini (L.) Skeels, commonly known as Jamun, Jambul, Java plum or Indian blackberry, is an important medicinal and nutritional plant belonging to the family Myrtaceae. The plant is widely distributed in South Asia and has a long history of use in traditional medicine. Various parts of *S. cumini*, including fruits, seeds, leaves, stem bark, flowers and roots, are used for medicinal purposes. The plant contains a wide range of bioactive phytoconstituents, including flavonoids, phenolic compounds, tannins, alkaloids, anthocyanins, terpenoids, fatty acids, vitamins and minerals. These constituents contribute to its diverse pharmacological properties. The present review summarizes the botanical characteristics, phytochemical constituents, nutritional value, traditional uses and pharmacological activities of *S. cumini*. Reported biological activities include antidiabetic, antioxidant, anti-inflammatory, anticancer, radioprotective, cardioprotective, gastroprotective, antidiarrhoeal and antimicrobial effects. Among these, the antidiabetic and antioxidant activities have received considerable attention. Studies also indicate that phenolic compounds, flavonoids and anthocyanins may contribute to antioxidant and protective effects, while leaf extracts have demonstrated potential against radiation-induced DNA damage. Overall, *S. cumini* represents a promising natural source of bioactive compounds with potential applications in traditional medicine, nutraceuticals and pharmaceutical research. However, further well-designed studies are required to establish the safety, effective dosage, mechanisms of action and clinical efficacy of its extracts and individual constituents.

SYZYGIUM CUMINI

Syzygium cumini (L.), commonly known as jamun, jambul, jambolan, Java plum, Indian blackberry, and black plum, Portuguese plum, Malabar plum, purple plum, Jamaica and damson plum. belongs to the family Myrtaceae. The fruit is native to South Asia, mainly Pakistan, India, Afghanistan, and Myanmar, and Pacific-

Asia, including Indonesia, the Philippines, Hawaii, and Australia, and it is also cultivated in Florida and Kenya. During ripening, the fruit is greenish and at maturity pink to shining crimson. The harvesting period of the fruit jamun in Asia starts usually in the monsoon season (June to July) and lasts 30 to 40 days.^[1]



Figure 1: *Syzygium cumini*.

S. cumini fruits (1.5 to 3.5 cm) exhibit sweet flavor and mild astringency. *S. cumini* fruits are eaten fresh, or as chutney, and jam. *S. cumini* juice is used for preparing summer drinks such as syrup, sherbet, and squash. The squeezed fruits are normally heated for 10 min and mixed with water, sugar, citric acid, and sodium benzoate for preservation.^[2]

S. cumini has been traditionally used as a medicinal plant. Different parts of the plant such as bark, leaves, seeds, and fruits have been employed in the treatment of various diseases. *S. cumini* fruit juice has been utilized, orally, to treat gastric complaints, diabetes, and dysentery.^[3]

Synonyms^[4]

- *Eugenia jambolana* Lam.
- *Myrtus cumini* Linn.
- *Syzygium jambolana* DC.
- *Syzygium jambolanum* (Lam.) DC.
- *Eugenia djouant* Perr.
- *Calyptanthes jambolana* Willd.
- *Eugenia cumini* (Linn.) Druce.
- *Eugenia caryophyllifolia* Lam.

History and Distribution

For long in the period of recorded history, the tree is known to have grown in the Indian sub-continent, and many others adjoin regions of South Asia such as India, Bangladesh, Burma, Nepal, Pakistan, Sri Lanka and Indonesia. It was long ago introduced into and became naturalized in Malaysia. In southern Asia, the tree is venerated by Buddhists, and it is commonly planted near Hindu temples because it is considered sacred to Lord Krishna.^[4]

Botanical Description^[5]

➤ Habitat

It is widely cultivated in Haryana as well as the rest of the Indo-Gangetic plains in India. West Indies, West Africa and some subtropical regions including Florida, California, Algeria and Israel.

➤ Appearance

S. cumini may reach 30 m tall, broad crown up to 11 m in diameter and a trunk diameter of 0.6-0.9 m.

➤ Used parts

Dried fruits, fresh fruit, seed, leaves, root bark, flowers.

➤ Leaves

Turpentine smell, and are opposite, 5-25 cm long, 2.5-10 cm wide, oblong-oval or elliptic, blunt or tapering to a point at the apex; pinkish when young, becoming leathery, glossy, dark-green above, lighter beneath, with a conspicuous, yellowish midrib when mature.

➤ Fruits

Appear in clusters of just a few or 10-40, are round or oblong, often curved, 1.25-5 cm long, turning from green to light-magenta, then dark-purple or nearly black, although a white-fruited form has been reported in Indonesia. Fruit is usually astringent, sometimes unpalatably so, and the flavour varies from acid to fairly sweet. Pulp is purple or white, very juicy, and normally encloses a single, oblong, green or brown seed, up to 4 cm long, though some fruits have 2-5 seeds tightly compressed within a leathery coat, and some are seedless.

➤ Flowers

Fragrant and appear in clusters 2.5-10 cm long, each being 1.25 cm wide and 2.5 cm long, with a funnel-shaped calyx and 4-5 united petals, white at first, becoming rose pink, shedding rapidly to leave only the numerous stamens.

➤ Seeds

2-5 seeds tightly compressed within a leathery coat.

➤ Barks

Rough, cracked, flaking and discoloured on the lower part of the trunk, becoming smooth and light-grey higher up.

➤ Flowering and fruiting

Start flowering from March to April. The fruits develop by May or June and resemble large berries.



Figure 2.

Phytochemical constituents^[6]

Jambolan is rich in compounds containing anthocyanins, glucoside, ellagic acid, isoquercetin, kaempferol and myricetin. The seeds are claimed to contain alkaloid, jambosine, and glycoside jambolin or antimellin, which halts the diastatic conversion of starch into sugar and seed extract has lowered blood pressure by 34.6% and this action is attributed to the ellagic acid content. The seeds have been reported to be rich in flavonoids, a well-known antioxidant, which accounts for the scavenging of free radicals and protective effect on antioxidant enzymes and also found to have high total phenolics with significant antioxidant activity and are fairly rich in protein and calcium. Java plums are rich in sugar, mineral salts, vitamins C, PP which fortifies the beneficial effects of vitamin C, anthocyanins and flavonoids.

- Leaves

The leaves are rich in acylated flavonol glycosides (Figure 3A), quercetin, myricetin, myricitin, myricetin 3-O-4-acetyl-L-rhamnopyranoside (Figure 3B), triterpenoids, esterase, galloyl carboxylase, and tannin.

- Stem bark

The stem bark is rich in betulinic acid, friedelin, epi-friedelanol, β -sitosterol, eugenin and fatty acid ester of epi-friedelanol, β -sitosterol, quercetin kaempferol, myricetin (Figure 1C and Figure 3D), gallic acid and ellagic acid, bergenins, flavonoids and tannins. The presence of gallo- and ellagi-tannins may be responsible for the astringent property of stem bark.

- Flowers

The flowers are rich in kaempferol, quercetin, myricetin, isoquercetin (quercetin-3-glucoside), myricetin-3-L-arabinoside, quercetin-3-D-galactoside, dihydromyricetin, oleanolic acid (Figure 3E), acetyl oleanolic acid, eugenol-triterpenoid A and eugenol triterpenoid B.

- Roots

The roots are rich in flavonoid glycosides and isorhamnetin 3-O-rutinoside.

- Fruits

The fruits are rich in raffinose, glucose, fructose, citric acid, mallic acid, gallic acid, anthocyanins; delphinidin-3-gentiobioside, malvidin-3-laminaribioside, petunidin-3-gentiobioside (Figure 3F), cyanidin diglycoside, petunidin and malvidin. The sourness of fruits may be due to presence of gallic acid. The color of the fruits might be due to the presence of anthocyanins. The fruit contains 83.70-85.80 g moisture, 0.70-0.13 g protein, 0.15-0.30 g fat, 0.30-0.90 g crude fiber, 14.00 g carbohydrate, 0.32-0.40 g ash, 8.30-15.00 mg calcium, 35.00 mg magnesium, 15.00-16.20 mg phosphorus, 1.20-1.62 mg iron, 26.20 mg sodium, 55.00 mg potassium, 0.23 mg copper, 13.00 mg sulfur, 8.00 mg chlorine, 80 I.U. vitamin A, 0.01-0.03 mg thiamine, 0.009-0.01 mg riboflavin, 0.20-0.29 mg niacin, 5.70-18.00 mg ascorbic acid, 7.00 mg choline and 3.00 mcg folic acid per 100 g of edible portion. One of the variety of jambolan found in the Brazil possesses malvidin-3-glucoside and petunidin-3-glucoside. The peel powder of jambolan also can be employed as a colorant for foods and pharmaceuticals and anthocyanin pigments from fruit peels were studied for their antioxidant efficacy stability as extract and in formulations.

- Essential oils

The essential oils isolated from the freshly collected leaf (accounting for 82% of the oil), stem, seed, fruits contain α -Pinene, camphene, β -Pinene, myrcene, limonene, cis-Ocimene, trans-Ocimene, γ -Terpinene, terpinolene, bornyl acetate, α -Copaene, β -Caryophyllene, α -Humulene, γ -Cadinene and δ -Cadinene, trans-ocimene, cisocimene, β -myrcene, α -terpineol, dihydrocarvyl acetate, geranyl butyrate, terpinyl valerate, α -terpineol, β -caryophyllene, α -humulene, β -selinene, calacorene, α -muurolol, α -santalol, cis-farnesol: lauric, myristic, palmitic, stearic, oleic, linoleic, malvalic, sterculic and

vernolic acids. Unsaponifiable matter of the seed fat was also chemically investigated.

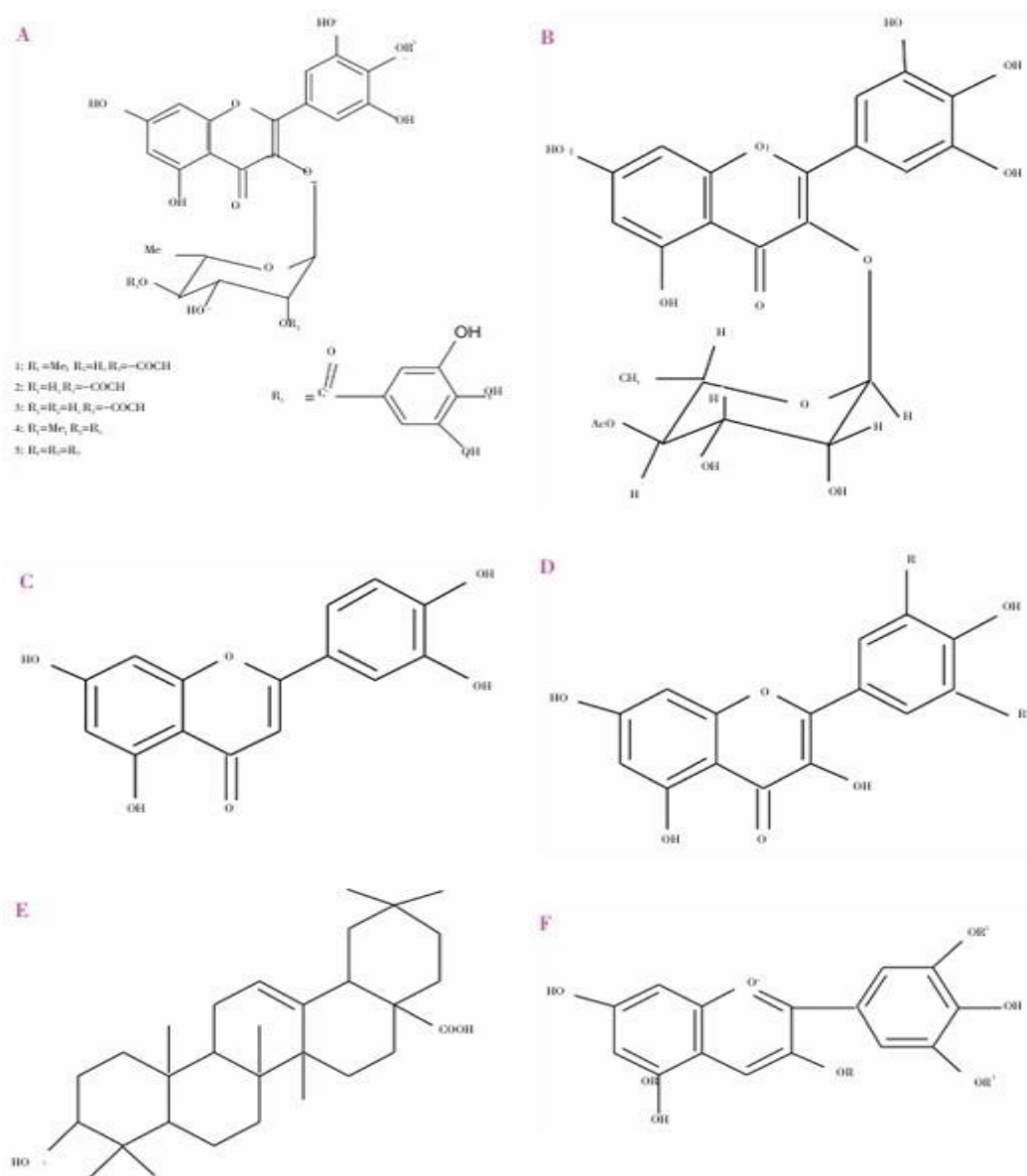


Figure 3: Phytochemical constituents of *S. cumini*.

A: Mearnsetin-3-O-(4''-O-acetyl)- α -L-rhamnopyranoside (1), myricetin 3-O-(4''-O-acetyl-2''-O-galloyl)- α -L-rhamnopyranoside (2), myricetin 3-O-(4''-O-acetyl)- α -L-rhamnopyranoside (3), myricetin 4'-methyl ether 3-O- α -L-rhamnopyranoside (4), myricerin (5); B: Myricetin 3-O-(4''-acetyl)- α -L-rhamnopyranoside; C: Quercetin; D: Kaempferol $R = H$; Myricetin $R = OH$; E: Oleanolic acid; F: Delphinidin-3-gentiobioside $R =$ Gentiobiose, $R' = H$; Malvidine-3-laminaribioside $R =$ Laminaribiose, $R' = Me$.

Medicinal properties

Medicinally, the fruit is reported to have antidiabetic, antihyperlipidemic, antioxidant, antiulcer, hepatoprotective, antiallergic, antiarthritic, antimicrobial,

anti-inflammatory, antipyretic, antiplaque, radioprotective, neuropsychopharmacological, nephroprotective and antidiarrheal activities. Among these beneficial physiological effects, the antidiabetic property of *S. cumini* has the most promising nutraceutical value.^[7]

➤ Anti diabetic activity^[8]

The leaves of plant contain alkanoids, lignins along with different phenolic acids. The seed of *Syzygium cumini* contain various phytochemical contents which is antidiabetic in nature. The seed of *Syzygium cumini* are rich in alkaloid, jambosine, glycoside which act as antidiabetic. The powder of seed is highly beneficial in reducing the blood sugar level. Jamun seed contain

alkaloids, which convert starch into the energy and help in the reduce the symptoms of diabetes. It helps in the reducing the thirsty feeling and frequent urination. Jamun seed in powdered form can reduce the blood sugar level.

➤ **Antioxidant Activity**^[9]

Antioxidants are considered to be key ingredients imparting health and protecting against various infections and degenerative diseases through radical scavenging capacity. The antioxidant potential of *S. cumini* extracts has been explored by employing a variety of in vitro assays. A considerable amount of tannins isolated from *S. cumini* peel using 70% aqueous acetone showed significant radical scavenging activities. *S. cumini* methanol leaf extract contained significant amounts of total phenolics and flavonoids, with good antioxidant status, suggesting the potential of *S. cumini* to treat various human disorders.

➤ **Anti-Inflammatory Activity**^[9]

S. cumini is a well-reputed medicinal plant with anti-inflammatory potential. The *S. cumini* water fruit extract exhibited considerable anti-inflammatory activity of 68.9%, while the standard diclofenac holds an anti-inflammatory potential of 75.1%. Similarly, a flavonoid-rich fraction of *S. cumini* fruits is reported to palliate inflammatory reactions in human lymphocytes, neutrophils, and monocytes against the hepatitis B vaccine. Likewise, the water seed extract of *S. cumini* reduced inflammation through action on human neutrophils.

➤ **Anticancer Activity**^[9]

S. cumini crude and methanol extracts were evaluated for cytotoxic activity against cultured human cancer cells, SiHa (carcinoma of uterus) and HeLa (cervical cancer). Results revealed a dose-dependent cell death against both cancer cell lines. Moreover, the 50% aqueous methanol fraction was reported to induce greater apoptosis in HeLa compared to SiHa cells. In addition, the ethyl acetate extract was found to be more promising compared to a methanol extract, and a similar trend was observed for DNA fragmentation, which is considered as an apoptosis indicator.

➤ **Radioprotection**^[9]

Phenolic compounds are known to be radioprotective with high biopotency as UV-A and UV-B blockers. The application of dichloromethane and methanol leaf extracts of *S. cumini* on human peripheral blood lymphocytes before irradiation (3 Gy) results in significant protection of DNA. Dichloromethane and methanol leaf extracts of *S. cumini* caused inhibition against radiation-induced micronuclei generation, representing the potential against radiation-induced DNA damage.

➤ **Hyperlipidemia and Cardioprotective Activity**^[9]

The *S. cumini* seeds flavonoid-rich fraction was evaluated for antilipidemic potential; results showed a reduction in low-density lipoproteins (LDL) levels and elevation of high-density lipoproteins (HDL) levels in rats. Similarly, the fraction reduced the serum lipid levels. Similarly, *S. cumini* seed water extract reduced triglycerides and LDL levels, whereas elevation of HDL levels was observed in alloxan-treated mice. Research findings also showed cardioprotective effects of *S. cumini* fruit ethanol extract.

➤ **Gastroprotective, Antidiarrheal Activity**^[9]

Gastric ulcer is the most commonly diagnosed illness of the human digestive system. The ethanol extract of *S. cumini* seeds reduces streptozotocin- and ethanol-induced peptic ulcers. The tannins from *S. cumini* offer excellent protection from hydrochloric acid- and ethanol-induced gastric ulceration by minimizing the gastric mucosal damage and as well known for their anti-diarrheal potential. *S. cumini* seeds mixed with jaggery (non-centrifugal cane sugar) were reported to impart relief from diarrhea and dysentery.

Uses in traditional medicine

All parts of the jamun can be used medicinally and it has a long tradition in alternative medicine. It is also an ancient medicinal plant with an illustrious medical history and has been the subject of classical reviews for over 100 years. It is widely distributed throughout India and ayurvedic medicine (Indian folk medicine) mentions its use for the treatment of diabetes mellitus. Various traditional practitioners in India use the different parts of the plant in the treatment of diabetes, blisters in mouth, cancer, colic, diarrhea, digestive complaints, dysentery, piles, pimples and stomachache. In Unani medicine various parts of jambolan act as liver tonic, enrich blood, strengthen teeth and gums and form good lotion for removing ringworm infection of the head.^[6]

➤ **Nutritional value of *Syzygium cumini***

Jamun fruit is a low-calorie, nutrient-containing fruit that provides carbohydrates, dietary components, vitamins and minerals. Research reviews report the presence of vitamin C, iron and other micronutrients, together with phenolic compounds, flavonoids, carotenoids and anthocyanins.

Important nutritional components include

- **Carbohydrates** – provide energy.
- **Dietary fibre** – contributes to digestive health and satiety.
- **Vitamin C** – contributes to antioxidant protection and normal immune function.
- **Iron** – important for haemoglobin formation.
- **Other minerals/micronutrients** – contribute to normal physiological functions.
- **Polyphenols and flavonoids** – including compounds such as gallic acid, ellagic acid, quercetin, myricetin and kaempferol.

- **Anthocyanins** – responsible in part for the dark purple colour of the fruit and associated with antioxidant activity.

The health-beneficial effects of *S. cumini* are mainly attributed to various phytoconstituents such as tannins, alkaloids, steroids, flavonoids, terpenoids, fatty acids, phenols, minerals, carbohydrates and vitamins present in the fruit.^[10]

Pharmacological action of *S. cumini*^[6]

Different parts of the jambolan especially fruits, seeds and stem bark possess promising activity against diabetes mellitus and it has been confirmed by several experimental and clinical studies. In the early 1960s to 1970s, Chirvan Nia and Ratsimamanga, Sigogneau-Jagodzinski et al, Lal and Choudhuri, Shrotri et al, Bose and Sepha and Vaish reported the antidiabetic activity of various parts of jambolan in diabetic animals. Tea prepared from leaves of jambolan was reported to have antihyperglycemic effect. The stem bark of the plant could induce the appearance of positive insulin staining cells in the epithelia of the pancreatic duct of treated animals and a significant decrease in blood glucose levels was also observed in mice treated with the stem bark by oral glucose tolerance test. Many clinical and experimental studies suggest that, different parts of the jambolan especially fruits and seeds possess promising activity against diabetes mellitus. Despite tremendous advancements have been made in the field of diabetic treatments, several earlier investigations have been reported from the different parts of jambolan with antioxidant, anti-inflammatory, neuropsychopharmacological, anti-microbial, anti-bacterial, anti-HIV, antileishmanial and antifungal, nitric oxide scavenging, free radical scavenging, anti-diarrheal, antifertility, anorexigenic, gastroprotective and anti-ulcerogenic, behavioural effects and radioprotective activities. Besides the above, the effect of various concentrations of the leaf extracts of the plant on the radiation-induced micronuclei formation was studied by Jagetia and Baliga.

CONCLUSION

Syzygium cumini (Jamun) is an important medicinal and nutritional plant belonging to the family Myrtaceae. Different parts of the plant, including fruits, seeds, leaves, bark, flowers and roots, contain a wide variety of bioactive phytoconstituents such as flavonoids, phenolic compounds, tannins, alkaloids, anthocyanins, terpenoids and fatty acids. These constituents contribute to its various biological and pharmacological activities.

The review indicates that *S. cumini* possesses several promising pharmacological activities, particularly antidiabetic and antioxidant effects. It has also been reported to exhibit anti-inflammatory, anticancer, radioprotective, cardioprotective, gastroprotective, antidiarrhoeal and antimicrobial activities. Among these, its antidiabetic potential has received considerable attention in experimental and clinical studies.

The presence of phenolic compounds, flavonoids and anthocyanins contributes to its antioxidant and other protective activities. Studies have also reported potential radioprotective effects of *S. cumini* leaf extracts against radiation-induced DNA damage.

Overall, *Syzygium cumini* has considerable potential as a source of natural bioactive compounds with possible applications in traditional medicine, nutraceuticals and pharmaceutical research. However, further well-designed studies are required to establish the safety, effective doses, mechanisms of action and clinical efficacy of its various extracts and constituents before their wider therapeutic application.

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