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SYZYGIUM CUMINI - FROM AYURVEDA TO MODERN RESEARCH

Adhish Mazumder[1], Prasenjit Mitra[2], Tanaya Ghosh[1] and Prasanta Kumar Mitra[1]*

[1]Department of Medical Biotechnology, Sikkim Manipal University, SMIMS, Sikkim, India.
[2]Department of Biochemistry, All India Institute of Medical Sciences (AIIMS), Jodhpur, Rajasthan, India.

***Corresponding Author: Prof. Prasanta Kumar Mitra**
Department of Medical Biotechnology, Sikkim Manipal University, SMIMS, Sikkim, India.

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ABSTRACT
Syzygium cumini Linn. (*S. cumini*) is one important medicinal plant. Since long different parts of the plant are being used for treatment of various ailments. In Ayurveda bark of *S. cumini* is described as acrid, sweet, digestive, astringent to the bowels, anti-helmintic and is good for sore throat, bronchitis, asthma, thirst, biliousness, dysentery, blood impurities as well as to cure ulcers. Syrup prepared from the ripe fruit of *S. cumini* is used in spleen enlargement and as efficient astringent in chronic diarrhoea. Hot water extract of dried fruits of *S. cumini* is used for stomach ulcers and to reduce acidity and for diabetes. These properties of *S. cumini* tempted modern researchers to undertake detailed pharmacological investigation of *S. cumini* and it has been found out that the tree parts have several pharmacological properties like anti-allergic, anti-diabetic, anti-gastric ulcer, anti-pyretic, anti-microbial, anti-spasmodic, anti-plaque, anti-diarrhoeal, anti-clastogenic, anti-hyperlipidemic, anti-fertility, anti-oxidant, anti-histamine, anti-cancer etc. The plant has also shown CNS related activity as well as radio protective, gastro-protective, hepato-protective and chemo-protective activities.

KEYWORDS: Syzygium Cumini, Use in Ayurveda, Pharmacological Activities.

INTRODUCTION
India is one of the very few nations in the world blessed with a diverse array of flora. About fifteen thousand plant species of India are reported to have medicinal properties in varying degrees. One such plant is *Syzygium cumini* Linn.[1] It belongs to Myrtaceae family.[2]

S. cumini is a large evergreen tropical tree and is known by different names viz. Black Plum in English, Jamun in Hindi, Jambu in Sanskrit, Jaman in Urdu etc. The synonyms used for the tree globally are, *Syzygium jambolana* DC., *Eugenia cumini* (Linn.) Druce., *Syzygium jambolanum* (Lam.) DC, *Myrtus cumini* L., *Calyptranthes jambolana* Willd, *Eugenia djouant* Perr., *Eugenia caryophyllifolia* Lam. Etc.[3] Though *S. cumini* is indigenous to India the tree is found throughout the Southeast Asia, Australia, South America, Eastern Africa, Madagascar and in other parts of the world.[4]

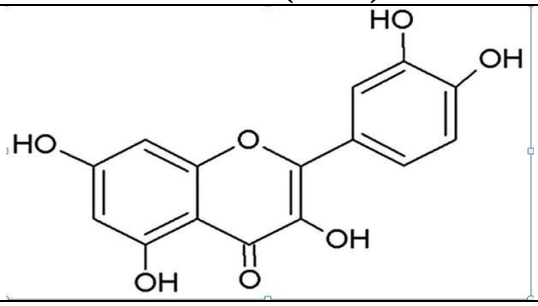
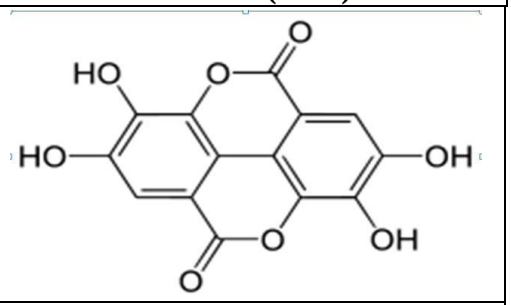
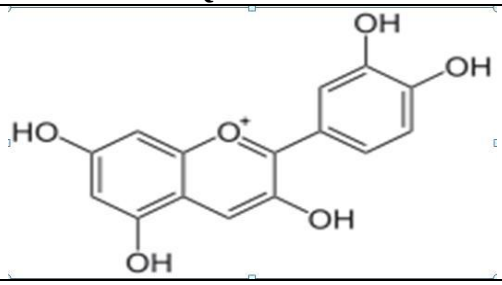
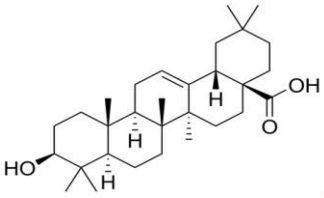
S. cumini, known as rapidly growing tree, grows as tall as 4-15 meters in height, leaves are 6 – 12 cm long. Flowers of *S. cumini* are numerous, pink or nearly white; fruits are1.5-3.5 cm long, dark purple or nearly black in colour and are edible.[5]

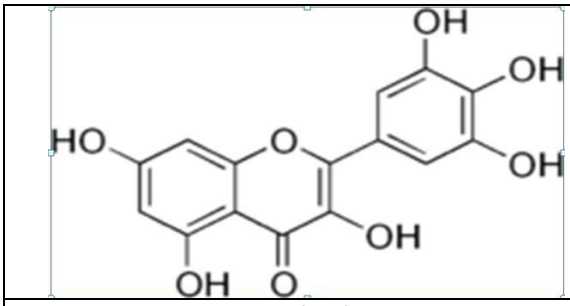
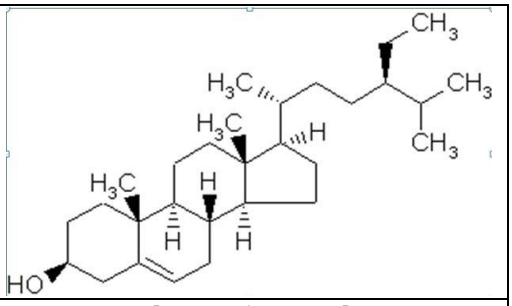
Scientific Classification of *S. cumini* is, kingdom – plantae, subkingdom - viridaeplantae ,infrakingdom - streptophyta, division - tracheophyta, subdivision – spermetophytina, infradivision – angiospermae, class - magnliopsida, superorder – rosanae, order – myrtales, genus – Syzygium and species - *Syzygium cumini* (L.) Skeels.[6]

Phytochemical studies confirmed presence of many phytochemicals in different parts of *S. cumini*. Stem bark contains betulinic acid, ß-sitosterol, friedeanol, epi-friedeanol and eugenin, ß-sitosterol-D-glucoside, Kamepferol-3-0- glucoside, quercetin, myricetin, astragalin, and gallic acid.[7,8] Root contains myricetin 3-o-glucoside and the flavonoid myricetin 3-o-robinoside.[9] Seeds contain glucoside jamboline, resin, gallic acid, ferulic acid guaicol, resorcinol, dimethyl ether and corilaginin.[10] Leaves contain gallitanins, essential oils like terpenes, 1-limonene and dipentene, monoterpenoid terpinene, terpenolene, borbeneol, terpineol and eugenol, polyphenols like gallic acid, methylgallate, kaempferol, ellagic acid, ellagitannin, nilocitin, myricetin 3-0-D- glucaronopyranoside, 3-0-ß D-glucuronopyranoside and two flavanol glycosides such as mearsetin 2-0-(4-0-acetyl)-a-L rhamnopyranoside, and myricetin 4-0-acetyl-2-0-gallate).[11-13] Flowers contain kaempferol, quercetin, myricetin, isoquercetin, myricetin- 3 - L - arabinoside, quercetin-3-D-galactoside, dihydromyricetin, oleanolic acid, acetyl oleanolic acid, eugenol-triterpenoid A and eugenol-triterpenoid B.[14]

Fruits contain malic acid, oxalic acid, gallic acid and tannins.[15,16]

Syzygium cumini* Linn *and different parts

	
***S. Cumini* (Tree)**	***S. Cumini* (Root)**
	
***S. Cumini* (Leaves)**	***S. Cumini* (Flower)**
	
***S. cumini* (Fruits)**	***S. cumini* (seeds)**
	
Quercitin	***Ellagic acid***
	
Cyanidin	***Oleanolic acid***

	
Myricetin	***beta - Sito sterol***

Due to presence of these vast phytochemicals all parts of *S. cumini* L. exert medicinal effect.

The effect was described in Ayurveda which has been subsequently confirmed in modern research. In this review article attempts have been made to enlist information of medicinal values of *S. cumini* – from the time of Ayurveda to modern research.

***Syzygium cumini* Linn. in Ayurveda**

In Ayurveda *S. cumini* is used as vatakara (increases vata), kantarti hara (relieves throat pain), pachani (improves digestion), atisara (diarrhoea, dysentery), shramahara (relieves tiredness), pittahara, dahahara (balances Pitta and its symptoms like burning sensation), rochana (improves taste, useful in anorexia), grahi (absorbent, useful in malabsorption syndrome and diarrhea) and vishtambhini (causes constipation, useful in diarrhoea and dysentery).[17]

According to Ayurveda[18]

1)*S. cumini* is beneficial in strengthening teeth and gum, very much beneficial for eye and skin and in mouth ulcer as well as in sore throat. The plant makes skin healthy and keeps it free from acne and pimple. It pacifies kapha and pitta dosha. The plant is also used as tonic for weakness. It treats anemia and improves sexual weakness.

2) Bark of *S. cumini* is acrid, sweet, digestive, astringent to the bowels, anti-helminthic and is good for sore throat, bronchitis, asthma, thirst, biliousness, dysentery, blood impurities and to cure ulcers. Bark is beneficial for depression and other nerve related disorders. Burk is also effective for females suffering from leucorrhea.

3) Fruits of *S. cumini* is a natural blood purifier and is capable of fighting germs of malaria and other infectious agents. Fruit is good for heart health and digestive system related problems. Fruit is also used in the treatment of cough, asthma and bronchitis. Syrup prepared from the ripe fruit of *S. cumini* is useful in spleen enlargement and efficient astringent in chronic diarrhoea. Hot water extract of dried fruits is used in stomach ulcers, diabetes and to reduce acidity.

4) *S. cumini* leaves are used to treat boils and to stop bleeding. Leaves also check vomiting and treat dysentery and fever specially when when the fever is associated with stomach upset.

5) Seed of *S. cumini* is considered a wonderful medicine for diabetes.

Treatment strategies of *S. cumini*, as mentioned in Ayurveda[19], are as follow

1) About 10 ml (2-3 tea spoonful) juice of ripe fruits of *S. cumini* three times daily has been recommended for the treatment of diabetes.

2) Warm juice of young leaves of *S. cumini* (2-3 tea spoonful) is helpful to treat blood dysentery.

3) Extract of *S. cumini* leaves (2-3 tea spoonful) mixed with 10/15 drops of honey checks vomiting.

4) Warm juice of *S. cumini* leaves (2-3 tea spoonful) is given to treat fever associated with stomach upset.

5) Juice of *S. cumini* leaves when applied to cut controls bleeding.

6) Juice of *S. cumini* leaves mixed with ghee checks bed wetting.

7) *S. cumini* leaves are boiled in water. The extract is used to treat boils.

8) Juice of *S. cumini* leaves is given to the patients suffering from burning feet.

9) Powder of *S. cumini* bark when used as tooth powder checks bleeding from teeth.

10) Ripe fruits of *S. cumini* mixed with rock salt increase appetite.

***Syzygium cumini* Linn. in Modern Research**

Modern researchers explained scientific basis of the uses of *S. cumini* in Ayurveda. According to them[20],

1)*S. cumini* fruit is good for heart health because the fruit could prevent generation of free radicals which are responsible for cardiovascular diseases.

2)*S. cumini* is used to treat anemia, general weakness as well as sexual weakness. This is due to aphrodisiac property of the herb.

3)Due to presence of oxalic acid and gallic acid, *S. cumini* fruit can fight against malaria and other bacterial infections.

4)*S. cumini* is beneficial for eye and skin due to its astringent property.

5)*S. cumini* fruit is rich in iron for which it can act as natural blood purifier.

6)Due to high content of vitamin A and C, *S. cumini* makes skin healthy.

7) Seed of *S. cumini* has low glycemic index and maintains blood glucose level. Seed, therefore, is a wonder medicine for diabetes.

The researchers further explored pharmacological activities of different parts of the plant e.g.

Anti-diarrhoeal Activity

Mukherjee et al. showed that ethanol extract of *S. cumini* could significantly decrease gastrointestinal motility in rats and thereby produce considerable inhibition of diarrhoea in the animals.[21] Aqueous extract of *S. cumini* seeds also showed dose dependent inhibition of castor oil induced diarrhoea in albino mice. The effect was through inhibition of prostaglandin synthesis. There was inhibition of intestinal motility thereby inhibiting diarrhoeal condition. The authors claimed that anti-diarrhoeal activity of aqueous extract of *S. cumini* seed was through its anti-secretory and anti-motility effect.[22]

Anti-allergic Activity

Brito et al., demonstrated that *S. cumini* Skeels has an action potential against allergic reactions. Authors claimed that the plant could inhibit eosinophil accumulation in an allergic pleurisy model which is due to impairment of certain chemokines such as CCL11 a.k.a. eotaxin and/or interleukins such as IL-5 production.[23] In another study, oral pre-treatment with *S. cumini* extract was found to inhibit edema formation to almost the same extent as promethazine which is a well known anti-histamine drug.[24]

Anti-diabetic Activity

Seeds of *S. cumini* when given to diabetic rat could cause significant decrease in blood glucose level of the animals. Mycaminose, a chemical compound present in the seed, was found responsible for this effect.[25] Elevated lipid profile in diabetic rats came to normal level after administration of *S. cumini* extract. *S. cumini* extract could elevate serum insulin levels and increase SOD and GPx activities in diabetic rats.[26-28] Seeds of *S. cumini* are known to possess protective functions against diabetes related complications like neuropathy, gastropathy, nephropathy, cataract and peptic ulcer.[29-31] Clinical trials were undertaken which revealed that *S. cumini* seed powder when given to Type II diabetic individuals could reduce fasting blood sugar, insulin resistance and elevate HDL cholesterol level at the end of 3rd month.[32] A polyherbal formulation (ADJ6) which contains *S. cumini* and some other anti-diabetic herbs has shown a high level of inhibitory action against α-glucosidase and α-amylase.[33]

Anti-inflammatory Activity

Muruganandan et.al. noted that the barks of *S. cumini* possessed a considerable degree of anti-inflammatory activity.[34] Extracts of *S. cumini* leaves and seeds has been known to show significant anti-inflammatory activity in carrageenan induced paw oedema in wistar rats.[35,36] The methanol extract from leaves showed 62.6% anti-inflammatory activity, which is considerably a very high degree of inhibition potential.[24]

Anti-oxidant Activity

Ethyl acetate fraction of the water components of the methanolic extract of of *S. cumini* leaves showed antioxidant activity against 2, 2 diphenyl-1-picrylhydrazyl (DPPH) free radical scavenging and ferric-reducing antioxidant power (FRA). HPLC attributed the presence of phenolic compounds such as ferulic acid and catechin responsible for antioxidant activity in the leaves.[37] Tannins extracted from *S. cumini* fruit had a significant amount of free radical scavenging activity and ferric reducing power at a dose of 500 µg.[38] Mitra et al studied anti oxidant activity of ethanol, methanol, acetone, ethyl acetate, chloroform and petroleum ether extracts of *S. cumini* leaf and found that methanol extract had maximum in vitro anti-oxidant activity as revealed by rate of inhibition of xanthine oxidase and linoleic acid peroxidation as well as scavenging capacity of DPPH.[39] Anti oxidant activity was comparable to that of synthetic anti-oxidant quercetin. Authors also studied effect of seasons on anti-oxidant property of *S. cumini* leaf and noted maximum anti oxidant activity during summer (March – May). They found that in summer there was maximum accumulation of phenolic compounds like ascorbic acid and flavonoids in the leaves of *S. cumini* which were responsible for anti oxidant activity.[40]

Anti-pyretic Activity

Chloroform extract of dried seeds of *S. cumini* possessed antipyretic activity. Methanol extract of dried seeds at doses of 50 mg/kg i.p. to rats was found more effective against yeast induced pyrexia.[41]

CNS related Activity

De Lima et.al. showed that different extracts, fractions and sub fractions from the seeds of *S. cumini* showed behavioural effects in mice which, according to authors, were related to the anticonvulsant actions besides hypothermic effect.[42] Investigations were also carried out in albino mice with ethyl acetate and methanol extracts of *S. cumini* seeds at specific dosages of 200 mg/kg and 400 mg/kg to note CNS related activity, if any. Results showed that *S. cumini* seeds had significant CNS related activity and this was due to the presence of saponins in the seeds. The same doses when administered orally reduced the rate of CNS activity markedly. Authors commented, *S. cumini* seeds had definitely CNS related activity.[43]

Anti-fertility Activity

It has been shown that flowers of *S. cumini* could significantly reduce the fertilizing potential of male albino rats. Authors found that this was due to oleanolic acid present in *S. cumini* flowers which could reduce the spermatid formation and there was premature arrest of spermatogenesis at the early stages of meiosis leading to

low sperm counts without any abnormality to germinal cells.[44]

Anti-microbial Activity

Stem, leaf and fruit extracts of *S. cumini* were found effective against a complete set of bacterial strains used in a study. Best results were observed against *Roultella plantikola* (zone of inhibition-25 mm).[45] Ethyl acetate and essential oil extracts of the *S. cumini* leaf were found effective against *Salmonella typhimurium, Bacillus subtilis, Pseudomonas aeruginosa, Staphylococcus aureus* and *Enterobacter aerogenes*.[46] Bark extract was noted to be useful for approximately 12 strains of *Vibrio cholera*.[47] Various strains of *S. cumini* extracts were taken to study their ascaricidal action against *Tetranychus urticae* Koch. Results showed the inhibition rates were 98.5%, 94% and 90% respectively for ethanolic, hexane and ethyl acetate extracts.[48] Aqueous extract of *S. cumini* leaves was also found to inhibit the goat pox virus [49] and the buffalo pox virus.[50] Methanolic extract of *S. cumini* has shown potential antifungal action against targeted pathogenic fungi such as – *Fusarium oxysporium*, *Rhizoctonia solani* and *Sclerotium rolfsii*.[51] α-pinene, the main component of essential oil of *S. cumini* was evaluated for its anti-lieshmanial action against *Leishmania amazonensis*. Results showed its efficacy in the dose of 19.7 mg/ml. Immunomodulatory action was considered as the most probable mechanism of action.[52]

Hepato-protective Activity

Aqueous leaf extract and methanolic seed extract of *S. cumini* showed hepato protective activity in experimental animals.[53,54] *S. cumini* extract rich in anthocyanins has been proved to be very useful in preventing the CCl_4 induced liver damage in rats. This was by halting the processes like lipid peroxidation, suppression in release of LDH etc. which are induced by CCl_4. Elevation of antioxidant activity (GPx) was also noted.[55]

Gastro-protective and Anti-ulcerogenic Activity

Gastro-protective and anti-ulcerogenic activity of the ethanolic extract of *S. cumini* seeds was studied in rats. Gastric ulcers were induced in 2 hour cold restraint stress model and effect of ethanolic extract of *S. cumini* seeds was observed. It was shown that the extract could decrease number of ulcers. Anti ulcer activity had relation with the anti-oxidant properties of *S. cumini* seeds extract.[56] In another study it was demonstrated that tannins present in *S. cumini* seeds could exert gastro-protective and anti-ulcerogenic effects in experimental animals.[57]

Chemo-protective Activity

S. cumini seed extracts in the dosage of 25 mg/kg b.w./day has broad spectrum chemo-protective effects. It could lower tumour burden, tumour incidence and cumulative number of gastric carcinomas induced by benzo-a-pyrene.[58] The alcoholic and aqueous extracts of *S. cumini* seed have shown chemo-protective action in oxidative stress and genomic damage.[59]

Radio-protective Activity

Radio-protective activity of *S. cumini* leaf extract was studied in mice. Mice was sickened by radiation induction (10GY γ-irradiation) and the effect *S. cumini* leaf extract was observed. It was noticed that the leaf extracts of *S. cumini* could reduce radiation sickness of the animals by providing protection against GI and bone marrow.[60] Effects of the leaf extracts were also studied on radiation induced alteration in micronuclei formation in cultured human peripheral blood lymphocytes. Results showed that the extracts could protect the cells against radiation induced damage.[61] Mitra et al. observed that acetone extract of *S. cumini* leaves had UV absorbing property at wavelength of 200 nm.[62] Maximum UV absorbing property was noted during rainy season due to presence of high amount of phenolic compounds in the plant leaves.[63] Intraperitoneal administration of hydroalcoholic extract of *S. cumini* seeds to mice in the dose of 80 mg/kg could help the animals to survive even after exposure of 6 to 11 Gy of γ radiation.[64]

Anti-clastogenic Activity: *S. cumini* extract has shown its utility in mutagenesis prevention and carcinogenesis initiation. Alcoholic extract of the seed could decrease hydroxyl radical induced strand breaks in pBR322 DNA in vitro and the aqueous extract has been found to reduce the chromosomal aberrations in mice induced by DBMA and urethane.[52] Oral administration of aqueous extract of *S. cumini* to mice can lead to increase the defense mechanisms through anti-oxidant release against genomic damage induced by carcinogens urethane and 7, 12-dimethylbez(a)anthracene.[64]

Anti-hyperlipidemic Activity: Oral administration of the ethanolic extract of *S. cumini* showed anti-hyperlipidemic activity at dosage of 100 mg/kg body weight on drug induced diabetic rats.[41] Seeds of *S. cumini* also exhibited hypolipidemic effects on diabetic rats.[65,66] This had relation with the flavonoids content of the seed. In hyperlipidemic rats administration of fruit pulp of *S. cumini* was found efficacious as it could decrease serum LDL cholesterols, triglycerides, total cholesterol and elevate HDL cholesterol levels.[67]

Anti-spasmodic activity: Ethanol-water(1:1) extract of dried bark of *S. cumini* was found possessing antispasmodic activity on guinea pig ileum.[68]

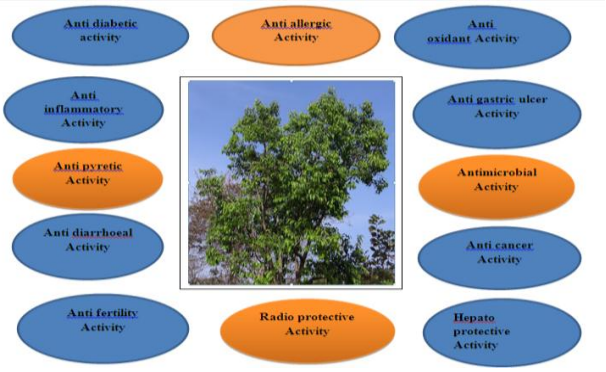
Anti-plaque activity: Bark extract of *S. cumini* can suppress plaque formation against *Streptococcus mutans*.[69]

Anti-cancer activity: Ethanol extract of *S. cumini* fruit showed strong anti-leukemia activity.[70] In another study it was demonstrated that acidic alcoholic extract of *S. cumini* fruits had significant cytotoxic activity against

cell lines of breast, cervix, brain, liver and lung carcinoma.[71]

Anti-histamine activity: Methanol extract of dried seeds of *S. cumini* was found active against histamine induced pedal edema in rats.[72]

Pharmacological activities of *Syzygium cumini* Linn.



Pharmacological activities of different parts of *Syzygium Cumini* Linn.

Part of *S. Cumini* Linn.	Pharmacological activities	References
Fruit	Anti oxidant Anti cancer Anti hyperlipidemic Anti microbial	38 70,71 67 45
Leave	Anti oxidant Anti viral Anti inflammatory Anti hyperlipidemic Anti microbial Hepatoprotective Radioprotective	37,39,40 49,50 24,35,36 41 45 53,54 60-63
Bark	Anti diabetic Anti plaque Anti spasmodic Anti microbial Anti inflammatory	73 69 68 47 34
Stem	Anti microbial	45
Seed	Anti diabetic Anti oxidant Anti bacterial Anti inflammatory Anti gastric ulcer Anti hyperlipidemic Anti histamine Anti pyretic CNS related activity Anti diarrhoeal Radio protective activity Gastro protective	25, 29-32 74 75 76 58,59 65,66 72 41 42,43 22 64 58,59
Whole plant	Anti hyperlipidemic Anti diabetic Anti allergic Anti microbial Hepatoprotective Anti diarrhoeal Anti clastogenic	41 26-28, 33 23,24 48, 51,52 55 21 52,64
Flower	Anti fertility	44

CONCLUSION

As per estimation of the World Health Organization, plant extracts are being used in traditional therapies of 80% of the world's population The Ayurveda included number of plants that have the treatment potential to various diseases. *S. cumini* is one such plant. In Ayurveda this plant has been described as a drug for different diseases and accordingly treatment strategies were formed. Modern researchers explored scientific basis of this treatment. They also evaluated pharmacological activities of the plant. Still there is scope to explore other medicinal values of this herbal tree. Many of the phytochemicals present in *S. cumini* are not isolated thereby yet to be tested for their roles in prevention of ailments. Even the phytochemicals which were isolated from the plant are not properly evaluated experimentally and/or clinically. It is expected that future researchers will undertake these studies.

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