



An Overview of Phytochemical, Therapeutic, Pharmacological and Traditional Importance of *Syzygium cumini*.

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Received January 12, 2019; accepted March 25, 2019; published online March 26, 2019

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Abstract: *Syzygium cumini*, generally bearing small black-purple drupes, is indigenous to Indian subcontinent and has diverse biological activities. It is also known as “jambul” & “kala jamun” in India. It belongs to the family Myrtaceae, the members of which have often antidiabetic, anti-inflammatory, anti-pyretic, anti-oxidant, antimicrobial, anticancer, antibacterial activities. *Syzygium cumini* has traditionally been used for its rich nutrition and medicinal value. It has diverse pharmacological actions. Different parts of plant (like bark, leaves, seeds, fruit etc.) have been used medicinally in treatment of various diseases. Seeds of *Syzygium cumini* have showed as anti-inflammatory, antioxidant, antibacterial, antidiabetic activities. Leaves of *Syzygium cumini* have been used for their antibacterial & antidiarrhoeal actions. Seeds of *Syzygium cumini* have been used as antibacterial, anti-inflammatory, antioxidant, & anticancer. Bark of *Syzygium cumini* has been used as diuretic. The ripe fruits of *Syzygium cumini* were found to have cardiovascular effects like hypotensive, vasorelaxant & antihypertensive in rats. *Syzygium cumini* has been used in diabetes since ages. Apart from this, it has also shown anti-allergic, anti-fungal, antibacterial, anticancer, anticlastogenic, antidiarrhoeal, antifertility, antihyperlipidemic, antihypertensive, radioprotective, chemoprotective, and hepatoprotective effects. This review will provide a platform for future researchers to describe the existing data on the information on traditional and medicinal use of the *Syzygium cumini* plant.

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Keywords: *Syzygium cumini*; antidiabetic activity; antibacterial; hepatoprotective



Various medicinal plants are present in a collection of herbal preparations of the Indian traditional health care system (Ayurveda) named “Rasayana”. From the ancient time, plants have been playing a key role for the betterment of mankind presenting as an extraordinary source of natural medicine (Veeram anjali et al, 2017). The use of *Syzygium cumini* was introduced in western medicine in the mid-nineteenth century, when the first reports on the investigation of its antidiabetic properties were published. (Chagas et al, 2015). *Syzygium cumini* (Figure 1 and 2) belongs to the family Myrtaceae. *Syzygium cumini* is also known as “Jambolan”, *Eugenia cumini*, “Jambul”, and “Kala Jamun” in India (Gajera H P et al 2017, Vijay Kothari et al, 2011; Arunpandiyam J. et al, 2017).

It is a large evergreen tree up to 30m height & a girth of 3-6m with a bole up to 15m found through India up to an altitude of 1800m (Dagadkhair et al, 2017) Today, these trees are found growing throughout the Asian sub-continent, Eastern Africa, South America, Madagascar & have also naturalized to Florida & Hawaii in the United States of America.(Shailendra Singh et al, 2018). *Syzygium cumini* is located in South Asia, India, Indonesia, Sri Lanka, Bangladesh as well as Nepal and some other countries. In India *Syzygium cumini* available more in Himalayas, Kerala, Karnataka, Andhra Pradesh, North India and East India (Reddy et al, 2017). The ripe fruits are used for health drinks, making preserves, squashes, jellies and wine. Different parts of the plant were also reported for their antioxidant, anti-inflammatory, neuropsychopharmacological, anti-microbial, anti-bacterial, anti-HIV, anti-leishmanial and antifungal, nitric oxide scavenging, free radical scavenging, anti-diarrheal, antifertility, anorexigenic, gastroprotective, anti-ulcerogenic and radio-protective activities (Baslingappa Shrikant et al, 2012).

In Brazil, the bark, fruits, seeds and leaves of this plant are used for the treatment of diabetes and administered in various pharmaceutical preparations (e.g., aqueous or alcoholic extract, decoctions or crude plant juice)(Ketylin Fernanda Migliato et al, 2009). The seed, bark, leaf & pulp are used in treatment of diabetes, allergies, viral infection, inflammation & gastric ulcer (Dagadkhair et al, 2017; Sharma Shweta et al, 2012). It also has diuretic, anti-nociceptive, hypothermic, chemoprotective and cardioprotective effect (Katiyar Deepti et al, 2016; Veeram anjali et al, 2017).

Taxonomical classification: (Veeram anjali et al, 2017, Jadhav V M et al, 2009)

Kingdom:	Plantae
Unranked:	Angiosperms
Order:	Myrtales
Family:	Myrtaceae
Genus:	<i>Syzygium</i>
Species:	<i>cumini</i>
Binomial name:	<i>Syzygium cumini</i> (L) Skeels.

Common names: (Bijaulia K Rohit et al, Jadhav V M et al, 2009)

Hindi:	Jamuna
Sanskrit:	Mahajambu, Ksudrajambu
Assam:	Jam
Bengali:	Jaam , Kalajam
English:	Jambul tree



Gujarat:	Gambu Jamun
Tamil:	Naval
Urdu:	Jamun
Telegu:	Neredu



Figure 1: *Syzygium cumini*



Figure 2: *Syzygium cumini*

Phytochemistry:

Syzygium cumini is found to be rich in tannins, alkaloids, carbohydrates, flavonoids, sterols, glycosides, and among other phytoconstituents in different parts of the tree (Bandiola et al, 2017) (Table 1; Figure 3). There are many families of phytochemicals and they help the human body in a variety of ways. Phytochemicals can protect human from diseases. Phytochemicals are non nutritive plant chemicals that have protective or disease preventive properties (Jadhav V M et al, 2009).



The fruits produce and determine the physical-chemical and sensory characteristics of light jambolan jelly. This fruit has intense purple color, which gave the jellies - both standard and light - a quite attractive visual aspect. (Lago-Vanzela et al, 2011) The phytochemical analysis of ethanol extract of Jamun stem bark, leaf, seed and fruit pulp showed the presence of alkaloids, anthraquinone glycosides, flavonoids, tannins, saponins, phenols, cardiac glycosides, terpenoids, phytosterols, steroids and amino acids in all extracts (Chaudhary et al, 2012).

Terpenoids and phytosterols were absent in the leaf extract (Jagetia Ganesh et al, 2005). The seeds are rich in protein and calcium. The seeds contain tannins (19%), ellagic acid, gallic acid (1-2%). A glycoside, jamboline, starch, myricyl alcohol in the unsaponified fraction of seed a small quantity (0.05%) of pale yellow essential oil (specific gravity₂₀: 0.926, $[\alpha]_D^{20}$ - 5.42°) are also present. (Abhishek et al, 2011). The essential oils isolated from the freshly collected leaf (accounting for 82% of the oil) [29], stem, seed, fruits contain α -Pinene, camphene, β -Pinene, myrcene, limonene, cis-ocimene, trans-ocimene, sterculic and vernolic acid (Muniappan Ayyanar et al, 2012; Chagas et al 2015).

Fruits contain malic acid as the major acid (0.59 of the wt of fruit), a small quantity of oxalic acid is also reported to be present (Dagadkhair et al, 2017). Gallic acid and tannins account for astringency of the fruit. The purple colour of the fruit is due to presence of cyaniding diglycosides. Fruit contain sugar (8.09%), non-reducing sugar (9.26%), glucose, fructose, mannose and galactose. The mineral constituents reported to be present (mg/100g of edible pulp) are Ca, Mg, Fe, Na, K, and Cu, . The vitamins present (in 100g. edible pulp) are vit.A, 80 IU; thiamine, 0.03mg, riboflavin, 0.01mg; nicotinic acid , 0.2 mg; vit.C, 18 mg; choline, 7 mg; folic acid, 3 μ g (Jadhav VM et al, 2009; Neha & Rani, 2013).

The stem bark contain friedelin, kaempferol, ellagic acid, gallotannin, betulinic acid, β -sitosterol, eugenin (Singh & Kaur, 2016; Baslingappa Shrikant et al, 2012). The leaves contains phenolic content like ferullic acid, catechin, also, n-dotricontanol, myricetin, mycaminose, quercetin, annic acid, tocopherol and acetylated flavonol glycoside (Chaudhary B et al, 2012).

The flowers contain oleanolic acid and other triterpenoids also acetyl oleanolin acid (0.3%) melting point (260-262°C), Eugenia- triterpenoid A (0.5%) and Eugenia triterpenoid B (0.3%) (Abhishek et al, 2011). The roots contain myricetin 3-O-glucoside and myricetin 3-O-robinoside.

Traditional uses:

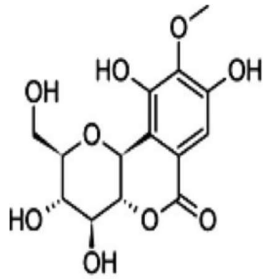
Traditionally, the jambul fruits, leaves, seeds, and bark all are used in Ayurvedic medicine. All parts of the tree can be used medicinally and it has a long history of use in traditional medicine (Dagadkhair et al, 2017). Seeds are used as hypoglycemic drug in diabetic rabbits (A glycoside in the seed, jamboline, is considered to have antidiabetic properties (Baslingappa Shrikant et al, 2012))

<i>Rasa</i> (Taste):	Kashaya (astringent), Madhura (sweet), Amla (sour)
<i>Guna</i> (qualities):	Laghu (light to digest), Rooksha (dry)
<i>Grahi</i> :	Absorbent, useful in malabsorption syndrome and diarrhea
<i>Vatakara</i> :	Increases Vata
<i>Shramahara</i> :	Relieves tiredness

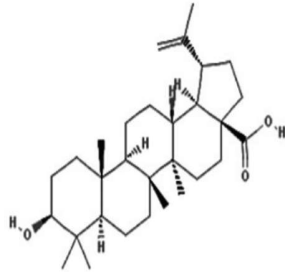


Table 1. The part of plant and their chemical constituents

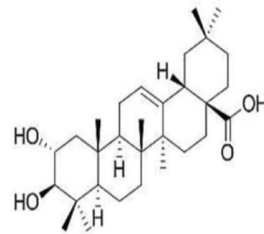
S.No.	Plant part	Metabolic class	Identified compounds	References
1.	Seeds	Polyphenols including Flavonoids, alkaloids, glycosides & phenolic compound, fatty oils	Quercetin, Rutin, 3,5,7,4- tetrahydroxy flavones, caffeic acid, ellagic acid, ferullic acid, albumen, fat, jambosine, ellagic acid , lauric , myristic, palmitic, stearic, oleic acid , linoleic, malvalic and vernolic acid and phytosterols such as β -sitosterol	Veeram anjali et al (2017) & Changdeo Amol et al . (2017)
2.	Leaves	phenolic content and acetylated flavonol glycosides	Ferrullic acid, catechin, cretegolic acid, n-dotricontanol, myrcetin, mycaminose, quercetin, tannic acid, BHA, Tocopherol	Zhi Ping Ruan et al . (2008) & Jagetia Ganesh Chandra et al . (2017)
3.	Fruit	Tannins, Glycosides, Vitamin A, C	Oxalic acid, malic acid, gallic acid cyanidine diglycosides, thiamine, riboflavin, nicotinic acid, folic acid	Jadhav V. M. et al . (2009)
4.	Fruit pulp	Anthocyanins, volatile oils, terpenes	Petunidin, α -pinene, β - pinene, malvidin, peonidin, cyanidin, delphinidin, pelargonidin	Dagakhair et al (2017), Aqil Farrukh et al . (2012).
5.	Stem bark	Triterpenoids, Resin, Resin, Phytosterol	Oleanolic acid Eugenia-triterpenoid-A Eugenia-triterpenoid-B Ellagic acid, Pentacyclic triterpenoid- Betulinic acid, Pentacyclic triterpenoid- Friedelin, Myricetine, β -sitosterol, Myricyl alcohol	Ivan A R et al . (2006),
6.	Flower	Flavonoids, tannins, triterpenoids	Eratogolic acid, isoquercetin, quercetin, Kaempferol Oleanolic acid	Kokate C K et al . (2008)
7.	Roots	Flavonoids, glycosides	Isorhamine 3-o-rutinoside , myricetin 3-o-robinoside	Bijauliya Rahul kumar et al (2017)



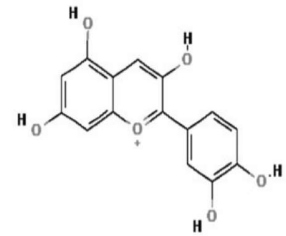
Bergenin



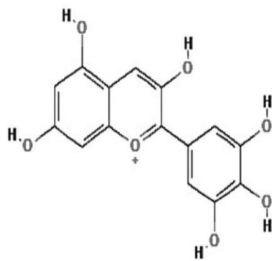
Betulinic acid



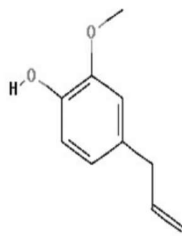
Crategolic acid



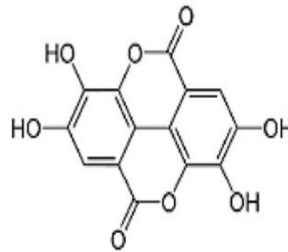
Cynidin



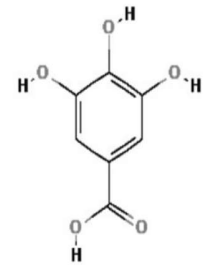
Delphinidin



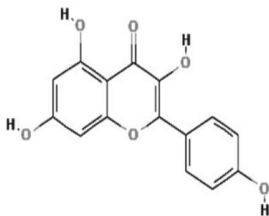
Eugenol



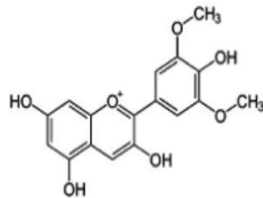
Ellagic acid



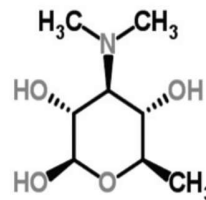
Gallic acid



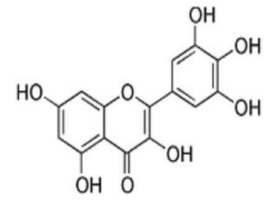
Kaempferol



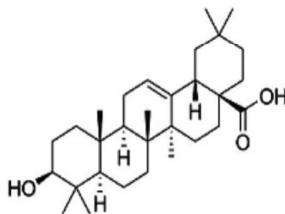
Malvidin



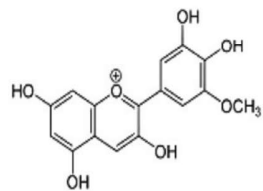
Mycaminose



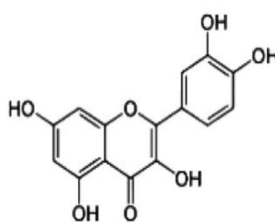
Myricetin



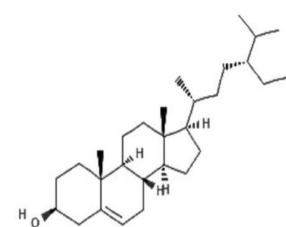
Oleanolic acid



Petunidin



Quercetin



β -sitosterol

Figure 3. Chemical structure of chemical constituents of *Syzigium cumini*



Bark decoctions are taken for asthma and bronchitis, used as mouth wash for the astringent effect on mouth ulcerations, and spongy gums and for stomatitis. (Anayat ulla et al, 2017). Fruit bark decoction is used for antiplasmodial activity. Decoction of root bark & stem bark is used to treat diarrhea, dysentery and dyspepsis (Jagetia G C et al, 2005). Juice of ripe fruit or decoction of fruit may be administered in enlargement of spleen, chronic diarrhea & urine retention. In India, extracts of both in liquid or powdered form are freely given orally, two or three times a day to patients with diabetes mellitus or glycosuria.

Pharmacological activities: Pharmacological activities are listed in Table 2.

Table 2. Pharmacological activities

1.	Anti-diabetic	Leave	Methanol, n-hexane	Vit.C, gallic acid, tannins, anthocyanins including cyanidin, petunidin, Lupeol, β -sitosterol	Streptozotocin induced diabetes	Rats	Alam et al . (2012)
2.	Anti-inflammatory	Bark	Ethanol	Ellagic acid, gallotannin, betulinic acid, β -sitosterol, eugenin, kaempferol	Carrageenin-induced paw oedema in rats, Kaolin-carrageenin-induced hind paw oedema in rats, Formaldehyde-induced hind paw oedema in rats, Cotton pellet granuloma in rats Carrageenin-induced paw oedema in rats	Rats & mice	Muruganandan et al (2000)
		Seed	Methanol, Acetate	triterpenoids, saponins and tannins	Indomethacin induced Acute Gastric Ulceration	Rats	Kumar et al . (2008)
		Leaf	Aqueous	phenolic compounds and flavonoids		Mice	Chanudom Lanchakon et al . (2015)
3.	Anti-oxidant & anti-microbial or antibacterial	Seed	Aqueous	Phenols and flavonoids	Candida Albicans infected diabetic rats	Rats	Paula E. R. Bitencourt et al . (2017)
		Stem	Aqueous & alcoholic		<i>In-vitro</i> - Agar well diffusion		



4.	Anti-allergic	Leaves	Aqueous	Ellagitannin, gallotannin and flavonoids	Mast-cell degranulator C48/80 induced anaphylaxis oedema	Mice	Brito et al . (2007)
		Roots	Aqueous	Ellagitannin, gallotannin and flavonoids	Clonidine induced catalepsy	Mice	Brito et al .(2007)
5.	Anti-hyperlipidemic	Plant pulp	Ethanol	Phenolic content- Flavonoids, Tannins, Triterpenoids	Triton X-100 induced hyperlipidemia	Rats	Singh Shailendra et al . (2018)
		Seed	Ethanol	Flavonoids, Alkaloids, Saponins, Tannins		Rats	Modi et al .(2009)
6.	Anti-hypertensive	Leaves	Hydroalcoholic	Flavonoids, Tannins, Triterpenoids		Rats	Ribeiro et al . (2014)
7.	Cardio & hepatoprotective	Seeds	Methanol	Flavonoids, phenolic content – caffeic acid, ellagic acid, ferulic acid, tannins, terpenes	CCl ₄ induced hepatotoxicity	Rats	Nahid et al . (2017)
8.	Diuretic	Bark	Methanol/Aqueous	Phenolic content- Flavonoids, Tannins	Furosemide induced diuretic	Rats	Chandavarkar et al . (2014)
9.	Antibacterial	Seed	Chloroform, petroleum ether, ethanol		<i>In-vitro</i> - Disk Diffusion method	E. coli, S. typhi, P. aeruginosa	Bhusari et al . (2014)
		Peel fruit	Ethanol		<i>In-vitro</i> - Disk Diffusion method	ATCC (American Type Culture Collection), Three gram positive bacteria	Edson J et al . (2015)
		Seed	Methanol fraction of ethanol extract		<i>In- vitro</i> - Agar cup method	E. coli, S. typhi, P. aeruginosa, B. subtilis	Yadav S. et al . (2011)
10.	Anti-cancer	Fruit pulp	Crude	Flavonoids, alkaloids, steroids	<i>In-vitro</i> -Trypan blue dye exclusion method	HeLa, SiHA	Barh et al . (2008)



	Anti-breast cancer	Fruit pulp	Methanol	Flavonoids, alkaloids, steroids	In-vitro -Trypan blue dye exclusion method	MCF-7 cell line	Tripathy et al . (2015)
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From the above study, it is clear that *Syzygium cumini* possesses various pharmacological activities including antioxidant, antibacterial, antidiabetic, antiobesity, anti-inflammatory, anti-fertility, antipyretic, antidysenteric, anticancer, anticlastogenic, hepatoprotective, diuretic, antihyperlipidemic, anti-allergic, anti-fungal, gastroprotective, anti-diarrhoeal, neuroprotective effects. In Indian literature like Ayurveda the plant is used for the treatment of diabetes. This review highlights the role of *Syzygium cumini* in various treatments and recommends that further phytochemical and clinical research should be done on this traditional medicinal plant for the discovery of safer drugs. Studies should also be on of mechanism of action.

DECLARATION OF CONFLICT OF INTEREST

We have no conflict of interest to declare.

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