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Review Article

The Jamun Journey: Exploring Microscopical, Phytochemical and Pharmacological Profile of *Syzygium cumini*

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ABSTRACT

India is one of the countries which contains huge heritage of traditional medicinal plants along with rich biodiversity to cope up the herbal needs for the treatment. One such plant is *Syzygium cumini*, part of the Myrtaceae family, also known as *Eugenia cumini* and *Syzygium jamunum*. Commonly referred to as Indian blackberry, it has several other names, including Jambul, Black Plum, Java Plum, Jamblang, and Jamun. Jamun is known for its antioxidant, anti-inflammatory, and cardioprotective effects, as well as its ability to manage cardiometabolic disorders, reduce hyperglycemia, and scavenge free radicals for treating persistent wounds, you can take a few fresh jamun leaves, make a paste, and apply it to the affected area. The leaves act as a natural antibiotic, promoting faster healing of injuries.

INTRODUCTION

Scientific Classification ^[1]:

- Kingdom: Plantae (unranked): Angiosperms (unranked): Eudicots (unranked): Rosids
- Order: Myrtales
- Family: Myrtaceae
- Genus: *Syzygium*
- Species: *S. cumini*
- Binomial name: *Syzygium cumini* (L.) Skeels.

- Synonyms: *Eugenia cumini* (L.) Druce, *Eugenia jambolana* Lam., *Syzygium jambolanum*

Plant Description:

A smooth tree of the Myrtaceae family, with leathery oblong-ovate to elliptical or obovate and 6-12 cm long, the tip being broad and shortly pointed. The plant is 4-15m in height. The panicles are born mostly from the branchlets below the leaves, often being axillary or terminal and 4-6 cm

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long. The flowers are scented, pink or virtually white, without stalks, and borne in crowded fascicles on the ends of the branchlets. The calyx is funnel shaped, about 4 mm long and 4 toothed. The petals cling and coalesce as a small disk. The stamens are profuse and as long as the calyx. Fruit is oval to elliptic, 1.5-3.5 cm long, dark purple or nearly black, luscious, fleshy and edible; only a single large seed exists [2].



Figure 1: Leaves, Fruit and Flowers of *Syzygium cumini*

Ayurvedic Properties:

- Rasa: Kasaya, Madhura
- Virya: Sita
- Guna: Laghu, Ruksha
- Vipala: Madhura, Katu
- Karma: Vatala, Pitahara

Origin and Distribution:

Syzygium cumini, also known as the black plum or jamun, is native to the Indian subcontinent and Southeast Asia. Its geographic distribution spans across various countries, including: India (origin), Thailand, Philippines, Madagascar, Other parts of Southeast Asia and others Florida, California, Israel. This tree species has been naturalized and cultivated in many regions, making it a widely available and culturally significant plant [3].

Nutritional composition of Indian black berries:

Table 1: Nutritional value per 100gms of *Syzygium cumini*

ENERGY	KCAL
Carbohydrates	15.56gms
Fat	0.23gms
Protiens	0.72gms
Water	83.13gms
Vitamin-A	3 IU
Thiamine(vit-B1)	0.006mg(1%)
Riboflavin(vit-B2)	0.012mg(1%)
Niacin(Vit-B3)	0.260mg(2%)
Pantothenic acid(B5)	0.160mg(3%)
Vitamin B6	0.038mg(3%)
Vitamin c	14.3mg(17%)
Calcium	19mg(2%)
Iron	0.19mg(1%)
Magnesium	15mg(4%)
Phosphorous	17mg(2%)
Potassium	79mg(2%)
Sodium	14mg(1%)

Bioactive Components:

In the 17th century the most important phytochemical research of the jamun recognised that around 35 components from various segments of the plant including, Polyphenols, Flavonoids, Phenolic compounds, Anti-inflammatory agents, Anthocyanins, Gallic acid, Tannins, Phenols, Alkaloids, Ellagic acid, Glycosides, Vitamins, Iso quersitine, Kaempferol, Myricetin, Flavonols and Flavone.[4]

The chemical constituents that are found in different parts of plants including:

Leaves: Contain flavonoids, phenolic compounds such as sitosterol, betulinic acid, crategolic acid, quercetin, myricetin, kaempferol, anti-cancer and hypoglycemic properties, Anti-oxidants with Anti-inflammatory [5]

Seeds: Rich in Anti-oxidants, Flavonoids, Protein and calcium [6]

Fruits and Other Parts: Contain Terpenoids, Glycosides, Saponins and other chemical compounds. The jamun plant contains bioactive compounds that help regulate blood sugar levels specifically, Jambolin, a glycoside found in Jamun, prevents starch from being converted into sugar, aiding in blood sugar control [7]

The plant's bioactive components, particularly ellagic acid, have been linked to several health benefits, including:

- Anti-inflammatory effects
- Neuroprotection (Protecting the nervous system)
- Cardio protection (Protecting heart)
- Anti-oxidant properties
- Anti mutagenic effects (Preventing genetic mutations)
- Ellagic acid is also marketed as dietary supplement, claiming to offer protection against Cancer, Cardiovascular diseases (CVDs), chronic kidney disease (CKD) and Metabolic disorders [8]

Table 2: Bioactive composition of Jamun plant [9]

Plant Part	Bioactive Composition
Jamun leaves	polyphenols, flavonoids, terpenoids, saponins, and glycosides
Jamun whole Plant	polyphenols, and flavonoids
Jamun Fruit	Sitosterol, betulinic acid, crategolic acid, quercetin, myricetin, methyl gallate, and kaempferol are examples of flavonoids, terpenoids, and phenolics

Microscopic Analysis of *Syzygium cumini* Leaves:

Leaf Structure [10]

Under the microscope, the leaves of *Syzygium cumini* show, Epidermal cells with wavy walls on the upper surface (adaxial face). Epidermal cells

with straight or slightly wavy walls on the lower surface (abaxial face). Secretory cavities on both surfaces

Cuticle and Stomata [11]

The epidermal cells are covered by a smooth cuticle. The leaf blade has stomata (breathing pores) mainly on the lower surface (hypostomatic). Two types of stomata were identified: anomocytic and anisocytic. Previous studies have reported varying types of stomata and leaf structures for *Syzygium cumini*. This study confirms the presence of anomocytic and anisocytic stomata.

Trichomes [12]

No trichomes (small hair-like structures) were observed on the leaf blade of *Syzygium cumini*, although they are common in the Myrtaceae family. A study of 17 *Syzygium* species in Thailand, including *S. cumini*, found that none of them had trichomes (small hair-like structures) on their leaves. This supports the observation in our study that *S. cumini* leaves do not have trichomes.

Midrib Structure

The midrib of *Syzygium cumini* has a unique shape, being slightly concave on the upper surface (adaxial face) and slightly convex on the lower surface (abaxial face).

Epidermis and Vascular Bundle

The epidermis is composed of a single layer of rounded cells covered by a thick cuticle. A bicollateral vascular bundle is located in the central parenchyma region of the midrib, surrounded by sclerenchyma cells.

Characteristics of Vascular Bundle



The bicollateral type of vascular bundle is typical of the Myrtaceae family. Previous studies have also reported this type of vascular bundle for *Syzygium cumini*.

Druses and Secretory Cavities ^[13, 14]

Druses (small crystal clusters) are found in the parenchyma and phloem tissues. Secretory cavities are present in the midrib and mesophyll, which typically secrete oily substances in the Myrtaceae family. The mesophyll tissue of *Syzygium cumini* has an isobilateral arrangement (Fig. 2e). This characteristic is commonly found in the Myrtaceae family, as reported by previous studies

Mesophyll Structure ^[15]

The mesophyll is isobilateral which is a predominant feature in the family Myrtaceae. The mesophyll tissue of *Syzygium cumini* consists of Palisade Parenchyma, Located below both sides of the epidermis comprises 2 layers on the upper surface (adaxial face) and 1 layer on the lower surface (abaxial face). Spongy Parenchyma, Comprises 7-9 layers of irregular cells and Contains druses (crystal clusters) with an average diameter of $22.82 \mu\text{m} \pm 4.02$

Crystal Distribution ^[16]

A study of *Syzygium* species found varying distributions of crystal types. Some species have mostly druses and rare prismatic crystals and Others have mostly prismatic crystals and rare druses. Some species have an equal occurrence of both druses and prismatic crystals.

Distribution of Bioactive Compounds in *Syzygium cumini* ^[17, 18]

Phenolic Compounds

Phenolic compounds were detected in various tissues including, Epidermis, Midrib, parenchyma, Palisade parenchyma and Spongy parenchyma.

Tannins

Tannins were found in the same locations as phenolic compounds as well as Phloem and Secretory cavities

Triterpenes and Steroids

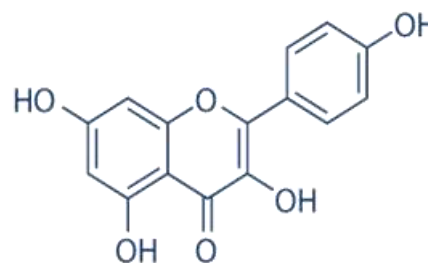
Triterpenes and steroids were identified in Secretory cavities, Collenchyma, Midrib parenchyma and Palisade parenchyma.

Alkaloids

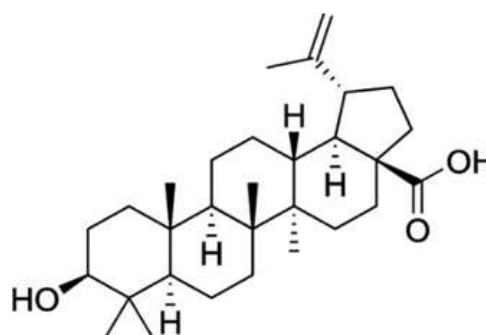
Alkaloids were detected in Midrib parenchyma and Spongy parenchyma

Essential Oils

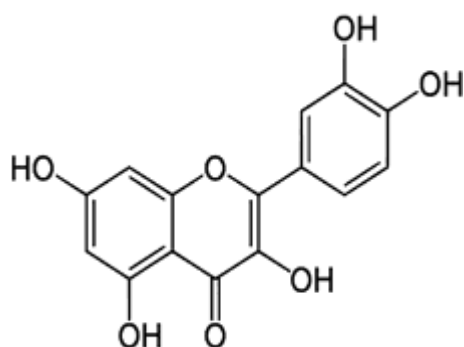
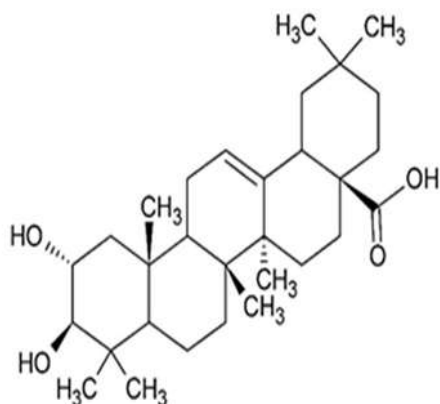
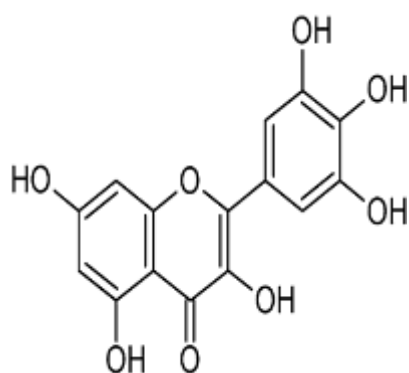
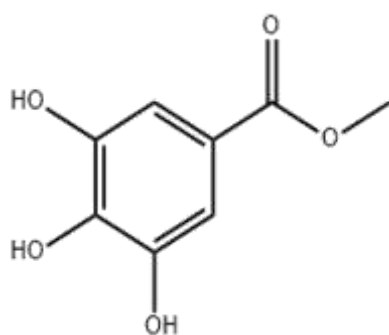
Essential oils were found in Secretory cavities.



Kaempferol



Betulinic acid

**Cratogeomycetic acid****Quercetin****Myricetin****Methyl gallate****Figure 2: Structures of some phytochemical constituents in *Syzygium cumini*****PHARMACOLOGICAL PROFILE:**

Syzygium cumini (S. cumini) has numerous pharmacological benefits including, Anti-diabetic, Anti-oxidant, Anti-inflammatory, Anti-bacterial, Anti-cancer, Neural dysfunction and impaired digestion. These benefits are attributed to phenolics and flavonoids present in the plant.

Anti-inflammatory effects: [19, 20]

Ethyl acetate and methanol extracts reduced swelling significantly. Effects were comparable to the standard anti-inflammatory drug diclofenac sodium. These findings establish the anti-inflammatory activity of S. cumini leaf extracts, making them potential natural remedies for inflammation. The study found that *Syzygium cumini* (S. cumini) leaf extracts have anti-inflammatory properties, particularly methanol extract showed significant anti-inflammatory activity.

Anti-Microbial activity: [21, 22]

Both methanol and aqueous leaf extracts exhibited antibacterial activity against *Bacillus subtilis*, *Salmonella typhi*, *Pseudomonas aeruginosa*, *Escherichia coli*, and *Proteus vulgaris*. Methanol extracts showed higher antimicrobial activity than aqueous extracts. The highest zone of inhibition (22mm) was observed against *Salmonella typhi*. S. cumini leaf and seed extracts contain various phytochemical compounds with potential medicinal importance. The antimicrobial activity of the extracts suggests their potential use in treating skin wounds, typhoid, and other bacterial infections. Further investigations are needed to explore the applications of S. cumini extracts. Phytochemical compounds in S. cumini extracts have antimicrobial and therapeutic potential. Methanol extracts showed higher antimicrobial activity than aqueous extracts.

Anti-Cancer activity: [23, 24]

Indian blackberries have anti-carcinogenic qualities because they are strong in flavonoids like anthocyanins and phenolic components like ellagic acids. They aid in destroying the free radicals present in the human body because of their antioxidant capabilities, so halting the growth of cancer's primary cause. Blackberries have been reported to be beneficial against a number of malignancies, including lung, oesophageal, skin, and colon cancer. Indian blackberries are rich in a variety of micronutrients and vitamins that stop the formation of malignant cells and prevent the development of tumours. The ability to resist oxidative damage is a crucial component in the treatment of several different illnesses

Neural dysfunction: [25]

According to studies, eating blackberries regularly can treat many neurological disorders and improve memory. Thanks to the polyphenolic substances it contains, the body's cognitive processes are improved.

Impaired digestion: [26]

It has both soluble and insoluble fibre, which enables improved digestion by ensuring greater absorption of water, minerals, and nutrients in the intestines. Blackberries' high fibre and nutrient content promotes better digestive health.

Against bacterial and viral infections: [27]

Indian blackberries are quite effective in fighting several bacterial and viral illnesses, which is attributed to their high phytoestrogen, vitamin, and mineral content. The ellagic acids present also aid in its anti-pathogenic properties. Thus, blackberries aid in boosting the body's immunity and shield it from a variety of microbial.

Anti-diabetic: [28, 29]

Indian blackberries are great for controlling blood sugar levels due to their high fibre and low sugar content. The significant fibre helps support healthy digestion and promotes a steady absorption of sugar. This balanced absorption helps regulate sugar levels in the body. Moreover, the potassium found in blackberries helps to regulate insulin levels, which can aid in preventing diabetes.

DISCUSSION AND CONCLUSION:

Syzygium cumini plant belonging to Myrtaceae family which is called Black Plum, Java plum, Jamblang contains various nutrients like carbohydrates, fats, proteins, water, vitamins along with few salts etc. includes chemical constituents like polyphenols, Anthocyanins, Phenols, Alkaloids, Glycosides etc which exhibit pharmacological activities like anti-diabetic, anti-oxidant, anti-inflammatory, anti-bacterial, anti-allergic, anti-cancer etc showing wide treating abilities from various parts of plants like leaves, bark, flowers, fruits from which we preferably consider leaves for various pharmacological activities.

In conclusion, the plan for extracting ethanolic leaf extract of *Syzygium cumini* involves a systematic approach to ensure effective extraction of bioactive compounds. The process begins with careful collection and proper drying of fresh leaves, followed by grinding to increase surface area. The ethanolic extraction method is then employed, leveraging ethanol's ability to dissolve a wide range of polar and non-polar compounds. After extraction, filtration, and concentration steps are implemented to isolate the extract. The final product will be subjected to analysis for its phytochemical content, ensuring the presence of compounds like flavonoids, alkaloids, and tannins, which are often associated with the plant's



medicinal properties. This methodology will not only standardize the extraction process but also facilitate future studies on the biological activities of *Syzygium cumini* leaf extract, such as its antioxidant, anti-inflammatory, or antimicrobial potential.

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