WORLD JOURNAL OF PHARMACEUTICAL RESEARCH
Coden USA: WJPRAP Impact Factor 8.453
Volume 15, Issue 3, 286-296. Review Article ISSN 2277–7105

FORMULATION AND EVALUATION OF JAMUN SEED TABLET AS NATURAL ANTI- DIABETIC AGENTS

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Article Received on 01 Jan. 2026,
Article Revised on 22 Jan. 2026,
Article Published on 01 Feb. 2026,

https://doi.org/10.5281/zenodo.18427550

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How to cite this Article: Ms. Shifa A. Attar[1], Mr. Vishal S. Madankar[1]*, Mr. Anil B. Panchal[2] (2026). Formulation And Evaluation Of Jamun Seed Tablet As Natural Anti- Diabetic Agents. World Journal of Pharmaceutical Research, 15(3), 286–296.

ABSTRACT

Jamun (*Syzygium cumini*) seeds have been widely recognized in traditional medicine for their potential to support diabetes management. They contain phytochemicals such as gallic acid, ellagic acid, quercetin, and kaempferol, which contribute to blood glucose regulation, enzyme inhibition, and antioxidant activity. Formulation of Jamun seed extracts into standardized tablets provides a convenient dosage form that improves stability, accuracy, and patient compliance. Experimental studies indicate that these tablets can lower fasting blood glucose, enhance insulin sensitivity, and protect against oxidative stress. Clinical findings further suggest their ability to improve long-term glycemic control. This review discusses the phytochemistry, mechanisms of action, formulation techniques, evaluation methods, and clinical perspectives of Jamun seed tablets, highlighting their potential role as natural diabetic agents. The jamun fruit, which is produced commercially in tropical and subtropical regions of the world for its excellent flesh that is sweet, sour, and astringent, is a member of the Myrtaceae family. Jamun fruit seeds are discarded as waste when fruit pulp is industrially processed into drinks, jellies, jam, vinegar, wine, and squash. Among the bioactive substances present in these seeds are

hydrolysable tannins, phenolic acids, flavonoids, other phenolics, terpenoids, phloroglucinol derivatives, and saponins. These substances have been connected to a variety of biological activities, such as antidiabetic, anticancer, anti-inflammatory, antioxidant, antimicrobial, antihyperlipidemic, and antihyper cholesterol emic effects, as well as cardioprotective, hepatoprotective, and neuroprotective properties. This review integrates phytochemical data, mechanistic insights, formulation strategies, and therapeutic evidence to provide a comprehensive understanding of the potential of Jamun seed–based interventions as natural, accessible, and cost-effective options for diabetes management. Future studies focusing on standardized extracts, dose optimization, and large-scale clinical trials are essential to fully establish their clinical relevance and safety.

KEYWORDS: Antidiabetic, flavonoid, Phenolic, Phytochemical, Polyphenol, hypoglycemic.

INTRODUCTION

In India and several nearby nations, the Unani System of Medicine (USM) is used as complementary, alternative, and traditional medicine. Herbo-mineral single medications and their formulations are added to the Unani pharmacopoeia. One of the significant medicinal plants with the ability to effectively treat a number of illnesses is jamun (Syzygium cumini Linn, Syn. Eugenia jambolana Lam.). It has been discovered that this plant is crucial for managing and preventing non-communicable diseases like diabetes mellitus, cancer, gout, and ischemic heart disease (IHD), among others. This plant has astringent, carminative, diuretic, antidiabetic, leucorrhea, antipyretic, and wound-healing properties according to the Unani System of Medicine.[1] Diabetes mellitus is a complicated metabolic condition that is defined by hyperglycemia and other clinical manifestations. It can lead to either insulin insufficiency or insulin dysfunction with disruption of the metabolism of proteins, fats, and carbohydrates. such are weariness, irritation, polyuria, polydipsia, and polyphagia. Ninety percent of people with diabetes have either Type I diabetes, which is insulin dependent, or Type II diabetes, which is not. One of the main causes of death is diabetes. In 2000, the anticipated global prevalence of diabetes across all age groups was 2.8%; by 2030, it is predicted to reach 4.4%. In 2000, there were 31.7 million diabetic patients in India; by 2030, that number is expected to rise to 79.4 million. The number of urban diabetics in emerging nations is expected to quadruple between 2000 and 2030. Although the exact pathophysiology of diabetes mellitus is unknown, experimental data points to the role of free

radicals in the disease's development and many lipoproteins metabolic anomalies in the emergence of complications.[6]

The Syzygium genus is thought to be the largest in the Myrtle family (Myrtaceae), with about 1200 species. The Indo-Malaysian tree Lithium cumini L., often called Jambul instead of Jambolana, is grown in tropical and subtropical regions for a variety of purposes. These uses include food, lumber, medicine, gardening, and dye. This Syzygium species is very valuable economically. This enormous, evergreen fruit tree, which is a member of the tropical evergreen flowering plant family, is found in the Indian subcontinent Myrtaceae. Though little is known about it, this native Indian fruit crop is regarded as one of the most significant fruit trees for medicinal purposes. It is native to the Indian subcontinent and the surrounding areas of China, Southeast Asia, and Queensland. The tree contains a lot of phenolic chemicals, including as tannins, ligands, phenols, and phenolic acids.[5]

HEALTH BENEFITS OF JAMUN[5,6]

1. Anti-diabetic effect

Due to its higher prevalence of morbidity and mortality, diabetes is one of the main causes of death worldwide each year. Jamun was a successful traditional treatment for diabetes mellitus. Previous research has verified that JSP's polyphenolic chemicals transform starch into energy, consequently regulating blood glucose levels. Additionally, it lessens symptoms like thirst and frequent urination.

2. Antimicrobial effect

Anti-microbial agents are compounds that either stop microorganisms from growing or even kill them. demonstrated the anti-microbial activity of the jamun seed phytochemical extract against a variety of gram-positive and gram-negative bacteria. The presence of monoterpene aldehydes and other bioactive substances, such as flavonoids like quercetin, isorhamnetin, and kaempferol, are responsible for the antibacterial action of jamun fruit.

3. Antioxidant effect

According to a number of studies, jamun fruit is a good source of natural antioxidants such ascorbic acid, anthocyanins, and phenolic compounds that shield cells from harm caused by free radicals. It is said to be a potent antioxidant that fights cancer and heart disease.

4. Anti-inflammatory activity and wound healing activity

In a severe burn wound model in albino rats, it was discovered that the formulations (10% ointment) of crude ethanolic extract of jamun (Syzygium cumini) bark had a faster healing effect than the control Nitrofurazone ointment (0.2% w/w, SmithKline-Beecham). Jamun seeds yield methanol and ethyl acetate, both of which have anti-inflammatory qualities. The extracts were found to significantly block the carrageenan-induced rat paw edema, a test that has significant approximation value for anti-inflammatory drugs operating by inhibiting the mediators of acute inflammation. They also showed no fatality rate up to the dose level of 2000 mg/kg. When compared to a dose of 5 mg/kg, the methanol extract at 400 mg/kg demonstrated strong anti-inflammatory efficacy at 4 hours, causing 62.6% inhibition.

5. Hepatoprotective activity

Drugs or medications used to treat a variety of illnesses may build up in the liver and cause harm, such as when paracetamol is used in excess. causes severe liver damage. Jamun pulp (Syzygium cumini) ethanol extract has been shown to have hepatoprotective effects in albino rats. The hepatotoxin that was used was paracetamol. When given 100 and 200 mg/kg/day of jamun pulp extract, they discovered that the rats (induced with paracetamol) had significant hepatoprotective activity against hepatotoxin, resulting in a decrease in the levels of all liver enzymes and total bilirubin and an increase in total protein.

PHARMACOGNOSY OF JAMUN (SYZYGIUM CUMINI) SEED[11]

1. Plant profile

Botanical Name: Syzygium cumini (L.) Skeels

Common Name: Jamun, Java plum, Black plum, Indian blackberry

Synonyms: Eugenia jambolana, Syzygium jambolanum

Family: Myrtaceae

2. Taxonomic hierarchy

Kingdom: Plantae

Phylum: Angiosperms

Order: Myrtales

Family: Myrtaceae

Genus: Syzygium

Species: Syzygium cumini (L.) Skeels

Fig. 1: Jamun plant parts - fruits, seeds, leaves and bark.

Table No 1: Major phytochemicals in Jamun seeds and their antidiabetic effects.

Phytochemical	Class	Anti Diabetic Effect
Gallic acid	Polyphenol	Strong antioxidant, Inhibits α-glucosidase
Ellagic acid	Polyphenol	Improves insulin sensitivity, anti-inflammatory
Quercetin	Flavonoid	Enhances glucose uptake, protects β-cells
Kaempferol	Flavonoid	Potent α-glucosidase inhibitor, regulates glucose
Ferulic acid	Phenolic acid	Antioxidant, supports insulin secretion

PHYTOCHEMICAL CONSTITUENTS

Leaves: Acylated flavanol glycosides, quercetin, myricetin, myricetin, myricetin 3-O-4-acetylrhamnopyranoside, triterpenoids, esterase, galloyl carboxylase, and tannin are all abundant in the leaves.[4] The ash from leaves strengthens teeth and gums. Making a decoction with an equal amount of its stem, bark, and leaves will get rid of the armpit odor. They are used as a paste to reduce the burning sensation in the body when burns occur.[1]

Fruits: Jamun fruits are traditionally valued as a general health tonic. They are believed to purify and nourish the blood and are commonly used to support liver function. The fruits are a good dietary source of iron and are employed in traditional medicine for managing conditions such as asthma, liver disorders, and certain heart-related ailments**.**[1]

Anthocyanins are primarily responsible for the characteristic deep purple coloration of Jamun fruits. The anthocyanin pigments extracted from the fruit peel have been extensively studied for their antioxidant activity and stability, both as isolated extracts and when incorporated into food and pharmaceutical formulations. Owing to these properties, Jamun peel powder is also considered a potential natural colorant for use in nutraceutical and food products.

The fruits contain a diverse range of phytochemicals, including raffinose, glucose, fructose, citric acid, malic acid, gallic acid, and various anthocyanins such as delphinidin-3gentiobioside, malvidin-3-laminaribioside, petunidin-3-gentiobioside, cyanidin diglycosidic, and malvidin. The slight sourness and astringency of the fruits are attributed mainly to the presence of gallic acid and organic acids.[4]

Seed: In Unani medicine, Jamun (Syzygium cumini) seeds are attributed with multiple therapeutic properties. They are described as Muḥallil-I-Awrām (anti-inflammatory) and are traditionally used to relieve joint pain and inflammation, reflecting their anti-arthritic potential. The seeds also possess Dafiʿ-i-Ḥummā (antipyretic) and Musakkin-i-Alam (analgesic) actions, along with notable Qābiḍ (astringent) effects due to their rich tannin content. For metabolic disorders, particularly Dhayābīṭus Ḥārr (diabetes mellitus), Jamun seeds are recognized as Dafiʿ-i-Dhayābīṭus (antidiabetic agents). They are traditionally believed to reduce excessive urinary sugar excretion and help alleviate the intense thirst associated with diabetes Additionally, Jamun seeds are used in conditions such as Musakkini-Sozish (relief from burning sensations), Ishāl-i-Damwī wa Ṣafrāwī (hemorrhagic and bilious diarrhea), Ḍuʿf al-Miʿda (weakness of the stomach), and Ḍuʿf al-Jigar (liver debility).[1] Jamun (Syzygium cumini) bark contains a rich array of bioactive compounds, including phenolic acids such as gallic acid and ellagic acid, and hydrolyzable tannins like corilagin, 3,6-hexahydroxydiphenoylglucose, 1-galloylglucose, 3-galloylglucose, and 4,6hexahydroxydiphenoylglucose.[4]

Bark: The astringent quality of stem bark may be caused by the presence of gallo- and ellagitannins. Betulinic acid, friedelin, epi-friedelanol, β-sitosterol, eugenin, and fatty acid esters of epi-friedelanol, β-sitosterol, quercetin, kaempferol, myricetin, gallic acid, ellagic acid bergenins, flavonoids, and tannins are abundant in the stem bark.[4] The bark of Jamun (Syzygium cumini) possesses several therapeutic properties and is traditionally used as an anthelmintic, digestive aid, and astringent (Qābiḍ). In classical Unani literature, it is recommended for the management of respiratory conditions such as bronchitis (Iltihāb alShu‘ab) and bronchial asthma (Rabw), gastrointestinal disorders including dysentery (Zaḥīr), as well as for purifying the blood (Najis-i-Dam) and promoting the healing of ulcers (Qurūḥ). These medicinal attributes are attributed to the bark’s rich content of tannins, phenolic compounds, flavonoids, and other bioactive constituents, which contribute to its antioxidant, anti-inflammatory, and antimicrobial effects.[4]

PREFORMULATION STUDIES

Preformulation studies involve the investigation of the physical, chemical, and mechanical properties of Jamun (Syzygium cumini) seed powder prior to tablet formulation. These studies help determine the suitability of the material for successful compression and standardization of dosage forms.[2]

1. Organoleptic Evaluation

Preformulation begins with organoleptic assessment, including color, odor, texture, and appearance of Jamun seed powder. These characteristics provide preliminary insight into identity and quality of raw materials.[5]

2. Particle Size Analysis

Powder is subjected to sieve analysis or laser diffraction to determine particle size distribution. Particle size affects flow properties, compressibility, dissolution, and bioavailability of the final formulation.[10]

3. Bulk Density and Tapped Density

Bulk and tapped densities are measured using a graduated cylinder to assess packing behavior of the powder. These parameters help evaluate flowability and guide proper selection of excipients such as glidants or binders.[5]

4. Angle of Repose

The angle of repose is determined to assess flow characteristics of Jamun seed powder. This data is essential for designing hopper size, die filling efficiency, and blending uniformity during manufacturing.[2]

5. Compressibility Index and Hausner Ratio

These indices are calculated from bulk and tapped densities to determine the powder's compressibility and predict its behavior during tableting, particularly its tendency for bridging or caking.[5]

6. Moisture Content Determination

Moisture content is assessed using a moisture analyzer or loss-on-drying method. Moisture influences powder flow, microbial stability, granulation behavior, and tablet hardness.[6]

7. Phytochemical Screening

Jamun seed powder undergoes qualitative phytochemical tests to detect constituents such as flavonoids, tannins, glycosides, alkaloids, and phenolics. These constituents contribute to therapeutic efficacy and are essential for herbal standardization.[9]

8. Compatibility Studies

Compatibility between Jamun seed powder and excipients is evaluated using techniques such as FTIR, DSC, or XRD to identify potential interactions that may affect stability, dissolution, or potency of final formulations.[2]

The Steps are involved in Wet Granulation Technique[11]

Step 1: Ingredient Weighing and Sieving

Using a digital balance, precisely weigh each component. To guarantee consistent particle size, run the gum tragacanth, lactose/starch, MCC, and jamun seed powder through a #20 mesh sieve.

Step 2: Mixing Dry

To guarantee even distribution, combine all of the sieved powders (apart from jamun seed, lactose, microcrystalline cellulose, magnesium stearate, sodium starch glycolate, maze starch) in a bowl or blender until a moist, dough-like mass forms.

Step 3: Binder Solution Preparation

To create Hydroxypropyl Methylcellulose dissolve the polyurethane-phenolic- ketone in warm distilled water while stirring.

Step 4: Wet Massing

Stir the dry mixture and gradually add the binder solution until a moist, dough-like mass forms.

Step 5: Granulation

To create granules, run the moist mixture through a #20 or #22mesh sieve.

Step 6: drying Granules

Granules are spread out on trays and dried in a tray dryer set between 35°C until the moisture content is less than 2%.

Step 7: Re-sieving and sizing

Dried granules can be passed through a sieve with a #16 or #20 mesh to produce granules of uniform size.

Step 8: Lubricant addition and final mixing

For 10-15 minutes, mix the granules gently with the talc and magnesium stearate.

Step 9: Tables of Compression

Use a tablet machine with the proper die and punch size to compress the granules.

EVALUATION PARAMETERS

1. Appearance and Organoleptic Evaluation

Tablets are examined for shape, color, odor, uniformity, and presence of any defects. This ensures acceptable aesthetics and consumer compliance.[8]

2. Weight Variation Test

Uniformity of weight is evaluated by weighing individual tablets and comparing them with the average weight. This ensures uniform distribution of the active ingredient among tablets.[9]

3. Hardness Test

Tablet hardness is measured using a hardness tester to determine mechanical strength and ability to withstand handling, packaging, and shipping.[2]

4. Friability Test

Friability testing determines resistance to abrasion and breakage. It assesses the tablet's durability and ensures it can tolerate mechanical stress without significant weight loss.[5]

5. Thickness and Diameter Measurement

Tablet dimensions are measured using a Vernier caliper or thickness gauge. These parameters ensure batch-to-batch uniformity and proper die-punch selection during manufacturing.[3]

6. Disintegration Test

The disintegration time of tablets is measured in an appropriate medium at controlled temperature. This test ensures that tablets break down properly to allow drug release.[6]

7. Dissolution Study

Dissolution testing assesses the rate and extent of drug release from tablets in a simulated physiological environment. It is vital for predicting bioavailability and therapeutic performance.[8]

8. Content Uniformity Test

This test ensures each tablet contains the intended amount of active phytochemicals. It is conducted by dissolving and analyzing individual tablets using spectrophotometric or chromatographic methods.[10]

9. Stability Studies

Accelerated and real-time stability testing is performed to evaluate the effects of environmental factors like temperature and humidity on tablet strength, disintegration, and phytochemical integrity.[5]

CONCLUSION

The current study's findings indicate that S. cumini seed powder has hypoglycemic effects. As a result, it might become a viable candidate medication for the efficient management of blood sugar levels in individuals with type 2 diabetes and contribute to the decrease of diabetes related morbidity and mortality. Because it is affordable, it could improve the biochemical characteristics of diabetic patients living in rural areas.

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