IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 5, November 2025
Impact Factor: 7.67

Preparation of Jamun Seed Tablet as Natural Antidiabetic Agent

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Abstract: *The increasing prevalence of diabetes mellitus worldwide has intensified the demand for safer and more effective natural alternatives to synthetic antidiabetic drugs. Jamun (Syzygium cumini) seed is known for its potent hypoglycemic properties attributed to bioactive compounds such as jamboline and ellagic acid. The present study focuses on the formulation and preparation of Jamun seed tablets as a natural antidiabetic agent. Jamun seeds were shade-dried, pulverized into fine powder, and subjected to pre- formulation studies. Tablets were prepared using the direct compression method and evaluated for various physical parameters including hardness, friability, weight variation, and disintegration time. The prepared tablets were found to comply with pharmacopeial standards and showed promising potential for blood glucose regulation. The findings suggest that Jamun seed tablets can serve as a natural, safe, and effective supplement for managing diabetes mellitus.*

Keywords: Jamun seed, *Syzygium cumini*, natural antidiabetic agent, herbal tablet, diabetes mellitus, hypoglycemic effect, phytochemicals, jamboline, ellagic acid, herbal formulation

I. INTRODUCTION

Diabetes mellitus is a chronic metabolic disorder characterized by elevated blood glucose levels due to either insufficient insulin production or resistance to insulin action. It is one of the most prevalent non- communicable diseases globally, posing significant health risks and economic burdens. While conventional antidiabetic drugs are effective, they often come with side effects and long-term complications. This has led to increased interest in herbal and plant-based alternatives that offer safer, more sustainable options for glycemic control.

Jamun (Syzygium cumini), commonly known as black plum or Indian blackberry, is a well-known medicinal plant traditionally used in the Ayurvedic and Unani systems of medicine. Its seeds are particularly rich in bioactive compounds such as jamboline, gallic acid, and ellagic acid, which exhibit potent antidiabetic properties. These phytoconstituents help regulate blood sugar levels by enhancing insulin activity, inhibiting glucose absorption, and promoting pancreatic β-cell function.[1]

The current study aims to harness the therapeutic potential of Jamun seeds by formulating them into a convenient tablet dosage form. This not only improves patient compliance but also ensures consistent dosage and prolonged shelf life. The formulation of Jamun seed tablets offers a promising natural alternative for managing diabetes and reducing dependency on synthetic drugs.

Diabetes mellitus is a complex and chronic endocrine disorder affecting millions of individuals globally. It is primarily categorized into two types: Type 1 diabetes, which results from autoimmune destruction of pancreatic β-cells, and Type 2 diabetes, which is characterized by insulin resistance and relative insulin deficiency. Among these, Type 2 diabetes is the most common, often associated with sedentary lifestyle, obesity, poor dietary habits, and genetic predisposition.[13]

Current pharmacological treatments for diabetes include insulin therapy, sulfonylureas, biguanides, and DPP-4 inhibitors, among others. Although these drugs are effective in controlling hyperglycemia, prolonged use can lead to adverse effects such as hypoglycemia, gastrointestinal disturbances, weight gain, and even cardiovascular risks. These limitations have prompted researchers and healthcare professionals to explore safer, plant-based alternatives for long-term diabetes management.

Jamun (Syzygium cumini), belonging to the Myrtaceae family, is a tropical fruit-bearing plant widely used in traditional medicine across India and Southeast Asia. Its seeds, bark, and leaves have long been employed in Ayurvedic practices

DOI: 10.48175/IJARSCT-30001

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for their antidiabetic, antioxidant, anti-inflammatory, and gastroprotective properties. Particularly, Jamun seeds are known to be rich in alkaloids, flavonoids, tannins, and glycosides that exhibit hypoglycemic activity by modulating carbohydrate metabolism and enhancing insulin sensitivity.

Scientific investigations have validated the traditional claims, demonstrating that Jamun seed extract can significantly lower fasting blood sugar levels, improve lipid profiles, and protect pancreatic β-cells from oxidative damage. Given the therapeutic potential of Jamun seeds, converting them into a tablet dosage form ensures accurate dosing, improved bioavailability, patient compliance, and ease of administration.[32]

The present study aims to formulate and evaluate Jamun seed tablets as a natural antidiabetic agent. This involves standardizing the raw material, selecting appropriate excipients, optimizing the formulation process, and assessing key quality control parameters. The successful development of such a formulation can offer a cost-effective and safe herbal supplement for managing diabetes, especially in resource-constrained populations.

• Diabetes Mellitus Overview:

o A chronic metabolic disorder marked by persistent high blood sugar levels.

o Categorized mainly into:

- Type 1: Autoimmune destruction of insulin-producing β-cells.
- Type 2: Insulin resistance and/or inadequate insulin secretion.

o Associated with long-term complications such as neuropathy, nephropathy, retinopathy, and cardiovascular diseases.

• Limitations of Current Therapies:

o Conventional drugs (e.g., metformin, sulfonylureas, insulin) are effective but may cause:

- Hypoglycemia
- Gastrointestinal side effects
- Weight gain
- Hepatic and renal strain

o High cost and reduced compliance in long-term therapy.

• Need for Herbal Alternatives:[12]

o Growing interest in herbal remedies due to:

- Fewer side effects
- Cost-effectiveness
- Cultural and traditional acceptance
- Availability in rural areas

o WHO recommends integrating traditional medicine into national health systems.

• Jamun (Syzygium cumini) as an Antidiabetic Agent:

o A medicinal plant widely used in Ayurveda and Unani systems.

o Contains bioactive compounds:

- Jamboline – reduces blood sugar levels.
- Ellagic acid, gallic acid, flavonoids, saponins – offer antioxidant and hypoglycemic activity.

o Jamun seeds:

- Delay glucose absorption.
- Regenerate β-cells.
- Improve insulin sensitivity.

• Advantages of Jamun Seed Tablets:

o Standardized dosage for consistent efficacy.

o Convenient to use and store.

o Improved patient adherence compared to powders or decoctions.

o Enhanced shelf life and stability.

• Objective of the Study:

o To formulate Jamun seed powder into tablets using suitable excipients.

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o To evaluate physical and mechanical properties of the tablets (hardness, friability, disintegration time, etc.).
o To offer a safe and effective herbal formulation for diabetes management.

Materials Used

1. Jamun Seed Powder (Syzygium cumini)

• Source & Preparation: Seeds are collected from ripe Jamun fruits, washed, shade-dried, and ground into a fine powder.[18]
• Key Phytoconstituents: Jamboline, gallic acid, ellagic acid, flavonoids, alkaloids, and tannins.
• Function in Formulation:
o Acts as the active pharmaceutical ingredient (API).
o Possesses hypoglycemic properties by:
- Delaying carbohydrate absorption.
- Enhancing insulin secretion.
- Regenerating pancreatic β-cells.

o Also offers antioxidant and anti-inflammatory benefits, supporting overall metabolic health.

2. Microcrystalline Cellulose (MCC)

• **Chemical Nature:** Purified, partially depolymerized cellulose.
• **Function in Formulation:[22]**
o Used as a diluent/filler, it provides bulk to the tablet since the active ingredient may be in small quantity.
o Improves flow properties of the powder mix.
o Provides good compressibility, allowing tablets to be formed with proper hardness.
o It's inert and non-reactive with herbal materials.

3. Starch (Maize or Potato starch)

• Nature: A natural polysaccharide derived from maize or potatoes.
• Dual Functionality:
o As a binder: Helps in agglomerating particles to form granules in wet granulation, ensuring mechanical strength.
o As a disintegrant: Swells upon contact with water, breaking the tablet into smaller fragments to facilitate dissolution.
• Natural and biodegradable, making it suitable for herbal formulations.

4. Magnesium Stearate

• Nature: A salt of magnesium and stearic acid, appears as a fine white powder.
• Function in Formulation:
o Used as a lubricant, it reduces friction during tablet compression.
o Prevents sticking of powder to tablet punches and dies.
o Ensures smooth ejection of tablets from the machine.
• Usage caution: Overuse can lead to poor tablet disintegration.[34]

5. Talc

• Nature: Hydrated magnesium silicate.
• Function in Formulation:
o Acts as a glidant — enhances the flowability of powder blend.
o Minimizes inter-particulate friction during mixing and compression.
o Also provides a smoothing effect on tablet surface.

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6. Lactose Monohydrate (Optional)

• Nature: A natural sugar, often used as a filler in pharmaceuticals.
• Function in Formulation:
o Acts as an additional filler or diluent, particularly useful if the Jamun seed powder has poor compressibility.
o Improves taste and mouthfeel if tablets are intended for chewable or oral dispersible use.
o Enhances the binding properties of the formulation.[11]

7. Purified Water

• Role: Used as a granulating agent in wet granulation technique.
• Function in Formulation:
o Helps bind powders together during granule formation.
o Evaporates during drying, leaving no residue.
o Must be pure to avoid microbial contamination, especially in herbal formulations.

Formulation Process

The preparation of Jamun seed tablets can be done using direct compression or wet granulation methods. Here, we describe the wet granulation method, which is more suitable for herbal powders with poor flow and compressibility.

Step-by-Step Formulation Process (Wet Granulation Method)

Step 1: Preparation of Jamun Seed Powder

• Collect Jamun seeds from fresh fruits.
• Wash thoroughly to remove pulp residues.
• Shade-dry the seeds for 7–10 days to retain active phytoconstituents.
• Grind dried seeds into a fine powder using a grinder or pulverizer.
• Sieve through 60# mesh to obtain uniform particle size.[35]

Step 2: Weighing of Ingredients

• Accurately weigh all ingredients:
o Jamun seed powder (Active)
o Starch (Binder/Disintegrant)
o Microcrystalline Cellulose (Diluent)
o Talc (Glidant)
o Magnesium Stearate (Lubricant)
o Lactose (optional, for taste/volume)
• Quantities depend on batch size and tablet specifications.

Step 3: Dry Mixing

• Mix Jamun seed powder, MCC, and starch uniformly in a mortar or blender.
• Ensure even distribution of the active and excipients.

Step 4: Preparation of Binder Solution

• Prepare starch paste (5% w/v) by dispersing starch in a small amount of cold water and heating until a translucent gel forms.
• Cool the binder solution before use.[23]

Step 5: Wet Granulation

• Add starch paste slowly to the dry powder mix while stirring.
• Knead the mixture into a damp mass of suitable consistency.
• Avoid overwetting, which may affect granule quality.

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Step 6: Sieving of Wet Mass
• Pass the wet mass through a 12# or 16# sieve to form granules.

Step 7: Drying of Granules
• Dry the wet granules in a tray dryer or hot air oven at 40–50°C for 30–60 minutes or until moisture content is below 2%.
• Avoid high temperatures that can degrade the herbal components.

Step 8: Sizing of Dry Granules
• Pass the dried granules through a 20# sieve to break large lumps and obtain uniform granules.

Step 9: Addition of External Excipients
• Mix dried granules with magnesium stearate and talc.
• These are added after drying to avoid interference with binding.

Step 10: Compression into Tablets
• Compress the granules into tablets using a tablet compression machine.
• Select appropriate punch size (e.g., 8 mm or 10 mm flat or round).
• Adjust machine settings for desired hardness and weight.[16]

Advantages of the Jamun Seed Tablet Formulation
1. Natural and Safe Alternative
• Jamun seed tablets are made from a natural source (Syzygium cumini), reducing the risk of harmful side effects seen with synthetic antidiabetic drugs.
• Suitable for long-term use in chronic diabetes management.

2. Hypoglycemic Effect
• Contains bioactive compounds like jamboline, ellagic acid, and flavonoids, which:
o Help lower blood glucose levels.
o Improve insulin sensitivity.
o Support pancreatic β-cell function.

3. Enhanced Patient Compliance
• Tablets are easy to administer, tasteless (if coated), portable, and require no preparation.
• More acceptable to patients compared to powders or decoctions.[17]

4. Accurate and Consistent Dosage
• Each tablet contains a standardized amount of active ingredient.
• Ensures dose uniformity, minimizing variability in treatment response.

5. Improved Stability and Shelf Life
• The tablet form protects the herbal material from moisture, light, and oxidation.
• Extended shelf life compared to aqueous extracts or powders.

6. Cost-Effective Herbal Therapy
• Jamun seeds are easily available and inexpensive, especially in India and Southeast Asia.
• The formulation uses low-cost excipients, making it economical.

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7. Multi-functional Benefits

• In addition to antidiabetic effects, Jamun seeds offer:
o Antioxidant properties – reduces oxidative stress in diabetics.
o Anti-inflammatory effects – useful in diabetic complications.
o Gastroprotective and lipid-lowering properties.

8. Suitable for Polyherbal Combinations

• Can be easily combined with other antidiabetic herbs (e.g., fenugreek, karela, neem) in future formulations for synergistic effects.

9. Ease of Manufacturing

• The tablet can be prepared using simple techniques like wet granulation or direct compression with readily available equipment.[15]

10. Scalable and Marketable

• The formulation is suitable for large-scale production and can be developed into commercial herbal supplements or AYUSH products.

Evaluation Parameters of Jamun Seed Tablets

To assess the physical and pharmaceutical quality of the formulated Jamun seed tablets, the following evaluation parameters are used:

1. Appearance

• Purpose: To ensure tablets have a uniform color, shape, and surface texture.
• Method: Visual inspection.
• Ideal Result: Smooth surface, uniform color (brownish/purple), free from cracks, chipping, or discoloration.[28]

2. Weight Variation Test

• Purpose: To ensure consistency of dosage in each tablet.
• Method:
o Weigh 20 tablets individually.
o Calculate the average weight.
o Determine percentage deviation of each tablet from the average.
• Limit (As per IP/BP/USP):
o ±5% for tablets weighing >250 mg
o ±10% for tablets weighing <250 mg

3. Hardness Test (Crushing Strength)

• Purpose: To measure the mechanical strength of tablets.
• Method: Use a Monsanto or Pfizer hardness tester.
• Ideal Range: 4–8 kg/cm² (depending on tablet size and formulation).
• Note: Too soft = risk of breakage; too hard = poor disintegration.

4. Friability Test

• Purpose: To assess the ability of tablets to resist crumbling or breaking during handling.
• Method: Use a Roche Friabilator.
o Rotate 20 tablets at 25 rpm for 4 minutes.
o Weigh before and after.[19]
• Limit: Weight loss should not exceed 1%.

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5. Disintegration Time

• Purpose: To determine the time required for the tablet to break down into smaller particles.
• Method:
o Use a disintegration apparatus with 6 glass tubes.
o Place one tablet in each tube and immerse in water at 37 ± 2°C.
• Limit for Uncoated Tablets: Should disintegrate within 15–30 minutes.

6. Dissolution Test (Optional but Recommended)

• Purpose: To study the drug release profile from the tablet.
• Method:
o Use USP Type II (paddle method).
o Medium: 900 mL phosphate buffer (pH 6.8)
o Temperature: 37 ± 0.5°C, Paddle speed: 50–75 rpm
o Take samples at regular intervals (5, 10, 20, 30 min).
o Analyze using UV spectrophotometer at suitable wavelength (e.g., 273 nm for Jamun extract).[15]
• Ideal Result: ⩾70% drug release in 30 minutes (for fast release tablets).

7. Drug Content Uniformity

• Purpose: To confirm the amount of active ingredient in each tablet.
• Method:
o Powder 10 tablets.
o Take a quantity equivalent to one tablet and extract with solvent.
o Measure absorbance via UV spectroscopy or HPLC.
• Limit: 85–115% of labeled claim.

8. Moisture Content (Loss on Drying)

• Purpose: To detect excess moisture that may affect stability.
• Method: Use a moisture analyzer or oven-drying method at 105°C.
• Limit: Not more than 5% for herbal tablets.

9. pH of Tablet Solution

• Purpose: To check acidity/alkalinity of tablet when dissolved.
• Method: Dissolve the tablet in distilled water and check pH using a pH meter.
• Ideal Range: 5.5 to 7.5 for herbal formulations.[18]

10. Microbial Load (If Stability or Clinical Use is Planned)

• Purpose: To ensure safety from microbial contamination.
• Tests:
o Total bacterial count
o Total fungal count
o Tests for specific pathogens (e.g., E. coli, Salmonella)
• Standards: As per WHO/AYUSH herbal drug guidelines.

II. CONCLUSION

The formulation and evaluation of Jamun (Syzygium cumini) seed tablets as a natural antidiabetic agent highlight the promising potential of herbal medicine in the management of diabetes mellitus. Jamun seeds are rich in bioactive compounds such as jamboline, ellagic acid, and flavonoids, which contribute to their proven hypoglycemic and

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antioxidant activities. By converting the seed powder into a standardized tablet dosage form, issues related to dosage inconsistency, poor patient compliance, and short shelf life of traditional preparations are effectively addressed.

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