

Polyherbal Churna for Antidiabetic Activity: A Comprehensive Review on Herbal Approaches for the Management of Diabetes Mellitus

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Abstract: *Diabetes mellitus is a chronic metabolic disorder marked by elevated blood glucose due to impaired insulin secretion, insulin action, or both. Rising prevalence has encouraged the exploration of herbal medicines as complementary approaches to its management. This review examines the rationale for a polyherbal churna comprising jamun seeds (Syzygium cumini), fenugreek seeds (Trigonella foenum-graecum), amla (Phyllanthus emblica), turmeric (Curcuma longa) and cinnamon (Cinnamomum verum). It discusses their phytoconstituents, traditional uses, pharmacological properties and possible antidiabetic mechanisms, together with the scientific basis for combining them. It also outlines formulation development, physicochemical evaluation, phytochemical screening and in vitro antidiabetic assays. The review provides a scientific foundation for a standardized herbal churna and identifies areas needing further experimental investigation to establish its efficacy, safety and quality.*

Keywords: Diabetes mellitus, polyherbal churna, antidiabetic activity, herbal medicine, jamun seeds, fenugreek, amla, turmeric, cinnamon, in vitro evaluation

I. INTRODUCTION

Diabetes mellitus is a chronic metabolic disorder characterised by persistent hyperglycaemia arising from impaired insulin secretion, reduced insulin action, or both. When poorly controlled it leads to neuropathy, nephropathy, retinopathy and cardiovascular disease [2,3]. India carries one of the largest burdens worldwide: the ICMR-INDIAB study, which surveyed 113,043 adults across Indian states, reported a diabetes prevalence above 11% and a prediabetes prevalence of 15.3% [1]. Most cases are type 2 diabetes, in which peripheral insulin resistance combines with inadequate insulin secretion and is strongly associated with obesity, physical inactivity and unhealthy diet.

Conventional oral antidiabetic drugs are effective but can cause hypoglycaemia and weight gain, and lifelong therapy is a considerable economic burden. These limitations have renewed interest in medicinal plants, which are widely available, culturally accepted in India and generally perceived to cause fewer side effects than synthetic drugs [4].

Polyherbal formulations combine two or more herbs so that constituents may act on different targets or modify one another's absorption and disposition, an effect often described as synergy [5]. For most traditional combinations, however, this synergy is a hypothesis rather than a demonstrated fact, which makes appraisal of the evidence behind each ingredient an essential first step in rational formulation.

Churna is an Ayurvedic dosage form: a dry, finely powdered preparation of one or more drugs, each pulverised and sieved separately and then mixed homogeneously [6,7]. Churnas may be classified by composition (simple or



compound), by particle size (*sthula*, *sukhma* and *atyanta sukhma*, graded by sieve number) and by therapeutic action. They are simple, economical and easy to store and administer, which supports patient compliance. This review examines the evidence for a proposed polyherbal churna containing jamun seed (*Syzygium cumini*), fenugreek seed (*Trigonella foenum-graecum*), amla fruit (*Phyllanthus emblica*), turmeric rhizome (*Curcuma longa*) and cinnamon bark (*Cinnamomum verum*). Its objectives are to (i) synthesise published clinical and preclinical evidence on the antidiabetic effects of each ingredient; (ii) summarise in vitro enzyme-inhibition evidence for polyherbal formulations; and (iii) identify evidence gaps and outline a framework for preparing and evaluating the churna.

II. METHODOLOGY

2.1 Literature Search Strategy

A literature search was conducted to collect scientific information regarding the potential antidiabetic properties of the selected medicinal plants. Relevant research articles and review papers were searched using databases such as PubMed, Google Scholar and ScienceDirect.

2.2 Selection of Medicinal Plants

Five medicinal plants were selected for the proposed polyherbal churna based on their traditional medicinal uses, reported phytochemical constituents and potential antidiabetic properties. These include:

Jamun seeds (*Syzygium cumini*)
Methi seeds (*Trigonella foenum-graecum*)
Amla (*Phyllanthus emblica*)
Turmeric (*Curcuma longa*)
Cinnamon (*Cinnamomum verum*)

2.3 Inclusion Criteria

Research articles related to the antidiabetic properties of the selected medicinal plants.
Studies investigating phytochemical constituents and possible mechanisms of action.
Relevant in vitro, animal and human studies.
Review articles and scientific publications providing information on herbal approaches to diabetes management.
Publications available in English.

2.4 Exclusion Criteria

Articles unrelated to diabetes mellitus or the selected medicinal plants.
Publications with insufficient scientific information.
Duplicate articles.
Sources lacking adequate information to support their relevance to the review.

2.5 Data Collection and Analysis

Relevant information was collected from the selected publications, including botanical characteristics, phytochemical constituents, reported antidiabetic mechanisms and experimental findings. The collected information was organised and compared to understand the potential contributions of each herb to glucose regulation and antioxidant activity.

2.6 Review and Interpretation

The available evidence was critically reviewed to identify the potential benefits and limitations of the selected medicinal plants. Their possible complementary effects in a polyherbal formulation were discussed. Particular attention was given to differences in study methods, dosage, plant preparation and strength of evidence.



2.7 Research Gap

Although individual herbs have been investigated for their potential antidiabetic properties, further research may be required to establish the efficacy, safety, standardisation and possible synergistic effects of their combination in a polyherbal churna.

III. BOTANICAL PROFILE OF THE INGREDIENTS

Table 1 summarises the botanical identity and principal constituents of the five ingredients. All five are rich in phenolic compounds, and each has been proposed to act on a different part of glucose homeostasis.

Table 1. Botanical profile of the proposed churna ingredients

Ingredient	Botanical source and family	Part used	Principal constituents	Proposed role
Jamun (Black plum)	<i>Syzygium cumini</i> (L.) Skeels; Myrtaceae	Seed	Polyphenols, flavonoids (isoquercetin, kaempferol), anthocyanins, gallic acid, tannins, alkaloids	Phenolic and tannin contribution
Methi (Fenugreek)	<i>Trigonella foenum-graecum</i> L.; Fabaceae	Seed	Galactomannan fibre, 4-hydroxyisoleucine, trigonelline, diosgenin	Fibre and phytochemical contribution
Amla (Indian gooseberry)	<i>Phyllanthus emblica</i> L. (syn. <i>Emblica officinalis</i>); Phyllanthaceae	Fruit	Vitamin C, hydrolysable tannins, gallic and ellagic acid, flavonoids	Polyphenol and antioxidant contribution
Turmeric	<i>Curcuma longa</i> L.; Zingiberaceae	Rhizome	Curcumin, demethoxycurcumin, bisdemethoxycurcumin, volatile oils	Curcuminoid contribution
Cinnamon	<i>Cinnamomum verum</i> J. Presl (syn. <i>C. zeylanicum</i>); Lauraceae	Inner bark	Cinnamaldehyde, eugenol, cinnamic acid, procyanidins	Aromatic phenolic contribution

Jamun seed is traditionally used in diabetes and is rich in phenolics and tannins; its reported actions include improved insulin activity, lower postprandial glucose rise and protection of pancreatic cells through antioxidant effects. Fenugreek contributes soluble galactomannan fibre, which can slow gastric emptying and carbohydrate absorption, and 4-hydroxyisoleucine, which has been investigated for effects on insulin secretion. Amla supplies antioxidant hydrolysable tannins and ascorbate-related compounds relevant to diabetes-associated oxidative stress. Turmeric provides curcuminoids, studied for antioxidant and anti-inflammatory activity and for effects on insulin signalling; the activity of raw turmeric powder should not be equated with that of concentrated curcumin extracts. Cinnamon has been studied for effects on insulin sensitivity, glucose transport and carbohydrate digestion, but findings vary with species, preparation and dose, so an authenticated species and a standardised preparation are required.

IV. RESULTS AND DISCUSSION

Potential contribution of selected ingredients:

1. Jamun

Enzyme inhibition: Its extract can be investigated for α -amylase and/or α -glucosidase inhibitory activity.

Antioxidant potential: Its ability to scavenge free radicals can be evaluated using an appropriate in-vitro assay.

Polyherbal formulation: It can be studied alongside methi seeds, amla, turmeric and cinnamon to assess the activity of the combined formulation.





Comparative evaluation: The polyherbal formulation can be compared with individual extracts and a suitable positive control to investigate whether combination offers improved activity.

2. Fenugreek.



Delays carbohydrate absorption: The soluble fibre galactomannan may slow carbohydrate digestion and glucose absorption.

Enzyme inhibition: Fenugreek extracts have demonstrated inhibitory activity against α -amylase and other carbohydrate-digesting enzymes in experimental studies.

Possible improvement in insulin action: Certain constituents may influence insulin secretion and glucose uptake by peripheral tissues.

Antioxidant activity: Phenolic compounds may help reduce oxidative stress associated with diabetes.

3. Amla.

Antioxidant effect: Polyphenol may help neutralize free radicals and reduce oxidative stress.

Possible glucose activity: Experimental studies suggest that amla extracts may influence glucose metabolism.

Potential enzyme inhibition: Certain extracts and isolated compounds may inhibit enzymes involved in carbohydrate digestion.



Support for metabolic health: Amla has been investigated for possible effects on lipid metabolism and insulin sensitivity.



4. Turmeric.



Antioxidant activity: Curcumin may help reduce oxidative stress associated with hyperglycaemia.

Anti-inflammatory activity: Curcumin has been investigated for its effects on inflammatory pathways involved in metabolic disorders.

Possible improvement in insulin sensitivity: Experimental research suggests that curcumin may influence insulin-signalling pathways and glucose utilization.

Potential enzyme inhibition: Turmeric extracts may show inhibitory activity against carbohydrate-digesting enzymes in certain experimental systems

5. Cinnamon.

Phytochemical constituents: Contains cinnamaldehyde, eugenol, cinnamic acid and procyanidins.

Glucose regulation: Has been investigated for its potential role in regulating blood glucose levels.

Insulin sensitivity: Certain cinnamon constituents may influence insulin signalling and insulin sensitivity.

Carbohydrate metabolism: May influence enzymes involved in carbohydrate digestion.

Antioxidant activity: Phenolic compounds may help reduce oxidative stress.





Contribution to formulation: May complement the phytochemical properties of other herbs in the proposed polyherbal churna.

Polyherbal formulations in vitro. Paul and Majumdar tested six commercial Indian antidiabetic polyherbal formulations as hydroalcoholic and aqueous extracts. The best hydroalcoholic extract inhibited α -amylase by about 72.5% (IC₅₀ 579.65 μ g/mL, against 523.12 μ g/mL for acarbose) and α -glucosidase by about 88% (IC₅₀ 261.03 μ g/mL, against 471.61 μ g/mL for acarbose); flavonoid content correlated with α -amylase inhibition ($r^2 = 0.87$), and hydroalcoholic extracts generally outperformed aqueous ones [16]. The α -amylase IC₅₀ was in fact weaker than that of acarbose, and the authors note that cell-free results need validation in vivo.

Rationale for the combination. The ingredients have complementary hypothesised targets: carbohydrate digestion and absorption (fenugreek fibre, jamun and cinnamon phenolics), insulin secretion and signalling (4-hydroxyisoleucine, curcuminoids, cinnamaldehyde) and oxidative stress and β -cell protection (amla, turmeric and jamun polyphenols). This is a plausible design rationale, but synergy remains untested.

Safety. The reviewed trials were mostly short, and the jamun review states that long-term safety is unsupported [9]. Additive blood-glucose lowering with prescribed antidiabetic drugs is plausible and warrants clinical caution; in vitro results must not be extrapolated to patients.

4.3 Proposed formulation and evaluation framework

The proposed churna (Table 2) is prepared as follows: raw materials are authenticated, cleaned and dried; each ingredient is powdered separately and passed through a standard sieve (No. 80–100) to obtain a fine, uniform powder (*sukhma churna*); the powders are weighed according to the formula and mixed by geometric dilution until homogeneous; and the product is packed in clean, dry, airtight containers and stored in a cool, dry place away from light. Fenugreek mucilage can influence powder flow, hydration and mixing behaviour, so mixing uniformity requires attention.

Table 2. Composition of the proposed polyherbal churna (per 100 g)

Ingredient	Quantity	Proposed role
Jamun seed powder	25 g	Phenolic and tannin contribution
Fenugreek seed powder	25 g	Fibre and phytochemical contribution
Amla powder	20 g	Polyphenol and antioxidant contribution
Turmeric powder	15 g	Curcuminoid contribution
Cinnamon powder	15 g	Aromatic phenolic contribution
Total	100g	Final churna batch



Table 3. outlines the evaluation proposed for the finished churna. Following the in vitro evidence reviewed above, enzyme inhibition should be tested on hydroalcoholic as well as aqueous extracts, with acarbose as the reference standard, and activity reported as percentage inhibition at several concentrations and as IC50 [16].

Table 3. Proposed evaluation of the polyherbal churna

Parameter	Method	Purpose
Organoleptic properties	Colour, odour, taste, texture	Identity and batch consistency
Physicochemical properties	Moisture content (loss on drying), ash and extractive values, pH of aqueous solution	Quality and stability
Particle size and flow	Sieve analysis; angle of repose, bulk and tapped density, Carr's index, Hausner ratio	Uniformity and handling
Phytochemical screening	Qualitative tests for alkaloids, flavonoids, tannins, phenolics, saponins and glycosides	Confirm major constituent classes
In vitro antidiabetic activity	α -Amylase inhibition (DNSA method; UV-visible spectrophotometry) at graded concentrations, with acarbose as standard; α -glucosidase inhibition as an option	% inhibition and IC50 versus standard

V. CONCLUSION

A polyherbal churna of Jamun seeds, Methi seeds, Amla, Turmeric and Cinnamon is a simple, economical and traditionally grounded dosage form with a reasonable phytochemical rationale for antidiabetic investigation. The literature reviewed shows that its constituents have been associated with effects on carbohydrate digestion, insulin action and oxidative stress, though the strength of evidence differs between plants and preparations. The proposed physicochemical, phytochemical and in-vitro alpha-amylase inhibition studies will provide preliminary evidence on the formulation. As the experimental work has not yet been performed, no conclusion regarding the actual antidiabetic activity or efficacy of the formulation can be drawn at this stage; final conclusions will depend on the experimental results and on subsequent in-vivo and clinical validation.

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