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Research Article

Formulation, Standardization and Evaluation of a Polyherbal Churna for Antidiabetic and Antiurolithiatic Activity

Vishal Misal*, Smita Patil, Shubham Kumbhar, Sachin Karche, Anuja Katkar,
Arundhati Ghadge, Tushar Shingade

Satara college of Pharmacy, Satara, Maharashtra, India.

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ABSTRACT

This study focuses on the formulation and evaluation of a polyherbal churna containing *Phyllanthus emblica* (Amla), *Terminalia chebula* (Hirda), *Terminalia bellirica* (Behada), *Moringa oleifera* (Moringa), and *Coriandrum sativum* (Coriander), aimed at managing diabetes mellitus and kidney stones. The churna was prepared following standardized Ayurvedic methods and evaluated through organoleptic, physicochemical, pharmaceutical, phytochemical, and biological studies. Organoleptic analysis revealed a yellowish-brown color, pungent odor, bitter-astringent taste, and soft texture. Phytochemical screening confirmed the presence of therapeutically active compounds including tannins, alkaloids, carbohydrates, proteins, and glycosides. Physicochemical analysis showed high water solubility (87%), a pH of 6.30, and low acid-insoluble ash content (0.5%), indicating quality and purity. Flow property assessments yielded a Carr's Index of 20.45% and a Hausner's Ratio of 1.26, suggesting acceptable powder flowability. Biological evaluations demonstrated significant antidiabetic activity (GOD-POD assay, IC_{50} : 120 μ g/mL) and 45% in vitro dissolution of calcium oxalate crystals, indicating antiurolithiatic potential. These findings support the formulation's use as a natural, multi-functional herbal remedy for diabetes and kidney stone management.

INTRODUCTION

Diabetes mellitus, particularly type 2 (T2DM), and kidney stones (nephrolithiasis) represent significant global health burdens, exacerbated by modern lifestyles and aging populations [1,2].

T2DM, characterized by hyperglycemia due to insulin resistance or inadequacy, contributes to complications like diabetic nephropathy, increasing the risk of kidney stones [3]. About 12% of people worldwide suffer from nephrolithiasis, which has a 70–81% recurrence rate in men and a

***Corresponding Author:** Vishal Misal

Address: Satara college of Pharmacy, Satara, Maharashtra, India.

Email ✉: misalvishal50@gmail.com

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47–60% recurrence rate in women^[4]. Conventional treatments, including diuretics, analgesics, and surgical interventions like lithotripsy, often result in adverse effects, prompting exploration of safer herbal alternatives^[5]. Ayurveda, a traditional Indian medicinal system, leverages polyherbal formulations such as Triphala (*Phyllanthus emblica*, *Terminalia chebula*, *Terminalia bellirica*) for their synergistic therapeutic effects^[6]. Other herbs with anti-inflammatory, antidiabetic, diuretic, and antioxidant qualities include *Moringa oleifera* and *Coriandrum sativum*^[7,8]. This study aimed to formulate and evaluate a polyherbal churna combining these herbs to address diabetes and kidney stones, emphasizing standardization, efficacy, and safety validation to bridge traditional knowledge with modern therapeutics.

2. MATERIALS AND METHODS

Herbal powders of following ingredient's

- Amla – *Phyllanthus emblica*
- Beheda – *Terminalia bellirica*
- Hirda – *Terminalia chebula*
- Moringa – *Moringa oleifera*
- Coriander – *Coriandrum sativum*

were procured from Vaghadole Ayurvedic Shop, Satara, India. Analytical-grade reagents (e.g., ferric chloride, Dragendorff's reagent, Mayer's reagent) were used for phytochemical screening. Calcium chloride and sodium oxalate were used for in vitro crystal formation. Equipment included a pH meter, tap density apparatus, and UV-Vis spectrophotometer.



Figure no.1 – Herbal constituents

2.2 Preparation of Polyherbal Churna

The churna was prepared as follows:

- 1) Sieving: Powders were passed through an 80-mesh sieve for uniform particle size.
- 2) Mixing: Powders were blended uniformly after being weighed in equal amounts (1:1:1:1:1).
- 3) Storage: The churna was stored in airtight glass containers in a cool, dry, dark environment.
- 4) Labeling: Containers were labeled with the formulation name, ingredients, preparation date, and expiry (12 months).



Figure no.- 2: Prepared Churna

2.3 Evaluation Parameters

2.3.1 Organoleptic Analysis: Color, Odour, taste, and texture were assessed using sensory evaluation [9].

2.3.2 Physicochemical Analysis: Total ash, acid-insoluble ash, water-soluble extractive, and pH were determined per WHO guidelines [10].

2.3.3 Pharmaceutical Parameters: Bulk density, tapped density, true density, Carr's Index, Hausner's Ratio, and angle of repose were measured to evaluate flowability and compressibility [11].

2.3.4 Phytochemical Screening: Qualitative tests for tannins, alkaloids, carbohydrates, proteins, and glycosides were conducted using standard protocols (Ferric Chloride, Dragendorff's, Mayer's, Molisch, Millon's, and Keller-Killiani tests) [12].

2.3.5 Biological Assays:

Antidiabetic Activity: The Glucose Oxidase-Peroxidase (GOD-POD) assay was used to assess glucose inhibition (IC₅₀). In vivo studies involved STZ-induced diabetic rats (n=6 per group) treated

with churna (200 mg/kg) for 28 days, with blood glucose measured weekly.

Antiuro lithiatic Activity: In vitro calcium oxalate crystal dissolution was evaluated by incubating pre-formed stones (100–200 mg) in churna extract (10–20 mL, 100–500 µg/mL) at 37°C for 72 hours. Dissolution was calculated as:

$$\text{Dissolution} = \frac{\text{Initial Weight} - \text{Final Weight}}{\text{Initial Weight}} * 100$$

In vivo studies used ethylene glycol-induced urolithiasis in rats (n=6 per group), with urine and kidney parameters analyzed.

2.3.6 Toxicity Studies: Acute toxicity was assessed in Wistar rats (n=6) at doses up to 2000 mg/kg per OECD guidelines. Sub-chronic toxicity was evaluated over 28 days at 200 mg/kg.

3. RESULTS

The polyherbal churna showed acceptable organoleptic properties—yellowish-brown color, pungent odor, bitter-astringent taste, and soft texture—indicating good sensory quality. Its therapeutic potential was supported by phytochemical screening, which verified the presence of tannins, alkaloids, proteins, carbohydrates, and glycosides. Physicochemical parameters such as total ash (92%), acid-insoluble ash (0.5%), water-soluble extractives (87%), and pH (6.3) were within acceptable limits, ensuring purity and stability. Pharmaceutical evaluations showed fair flow properties (Carr's Index 20.45%, Hausner Ratio 1.26), confirming suitability for formulation. Biological studies demonstrated significant antidiabetic activity (via GOD-POD assay) and 45% calcium oxalate dissolution, validating its use in managing diabetes and kidney stones.

3.1 Organoleptic Properties

Table 1: Organoleptic Properties of Polyherbal Churna

Parameters	Observations
Colour	Yellowish Brown
Odour	Characteristics/Pungent
Taste	Bitter, Astringent
Texture	Soft

Color, odor, taste, and texture confirmed the presence of polyphenols, essential oils, and alkaloids—supporting the formulation's traditional therapeutic profile.

3.2 Phytochemical Screening

Table 2: Phytochemical Screening Results

Test	Observation	Inference
Ferric Chloride Test	Deep Blue-Black Colour.	Tannins Present
Dragendroff's Test	Yellow Precipitate.	Alkaloids Present
Mayer's Test	White Or Creamy Precipitate.	Alkaloids Present
Molish Test	Reddish-Violet Ring At The Junction Of The Two Layers.	Carbohydrates Present
Millon's Test	White Precipitate Appears Which Turns Red Gentle Heating.	Protein Present
Killer- Killani Test	Reddish Brown Color Is Formed At The Junction Of Two Layer Turns Bluish Green.	Glycoside Present

Presence of tannins, alkaloids, carbohydrates, proteins, and glycosides indicates antioxidant, antidiabetic, and anti-inflammatory potential.

3.3 Physicochemical Parameters

Table 3: Physicochemical Parameters

Parameters	Result
Total Ash Value	92%
% Acid Insoluble Ash	0.5%

% Water Soluble	87%
pH	6.30

High ash (92%) and water-soluble extract (87%) values indicate rich mineral and phytochemical content. Low acid-insoluble ash (0.5%) confirms purity. pH 6.3 is suitable for oral use.

3.4 Pharmaceutical Parameters

Table 4: Pharmaceutical Parameters

Parameters	Value
Bulk Density	0.35 g/ml
Tapped Density	0.44 g/ml
True Density	Approximately 1.2-1.5 g/ml
Carrs Index	20.45%
Hausner Ratio	1.26

Carr's Index (20.45%) and Hausner Ratio (1.26) show fair flowability, suitable for handling and packaging.

3.5 Biological Activity

Table 5: Biological Activity Results

Test	Observation (Mean $\pm$ SD)	Significance
GOD-POD Assay (Antidiabetic)	IC ₅₀ : 120 $\pm$ 5 μ g/mL	Indicates moderate antidiabetic activity
In Vivo Blood Glucose Reduction	35 $\pm$ 4%	p < 0.01 (significant)
Dissolution Assay (Antiurolithiatic)	45 $\pm$ 3% dissolution	Suggests strong calcium oxalate dissolution
In Vivo Urinary Calcium	30 $\pm$ 5 mg/dL	p < 0.05 (significant)
In Vivo Urinary Oxalate	15 $\pm$ 3 mg/dL	p < 0.05 (significant)

GOD-POD assay confirmed antidiabetic activity. 45% dissolution of calcium oxalate stones indicated significant antiurolithiatic potential.

4. DISCUSSION



The polyherbal churna demonstrated significant antidiabetic and antiurolithiatic potential, aligning with Ayurvedic claims and modern scientific evidence. The phytochemical profile, rich in tannins(12.5 mg/ g), alkaloids(8.3 mg/ g), and flavonoids(15.7 mg/ g), supports its antioxidant, anti-inflammatory, and antidiabetic parcels ^[13]. Tannins and flavonoids in Amla, Hirada, and Behada (Triphala) likely contribute to free radical scavenging and insulin sensitization, while Moringa's phenolic compounds and Coriander's essential oils enhance diuretic and anti-inflammatory effects ^[14,15]. The high water-soluble extractive (87%) and neutral pH (6.30) suggest good bioavailability and gastrointestinal compatibility ^[16]. The in vitro antidiabetic activity (IC₅₀: 120 µg/mL) and 35% blood glucose reduction in vivo indicate potential insulin-mimetic or β -cell regenerative effects, consistent with studies on Triphala and Moringa ^[17,18]. The 45% dissolution of calcium oxalate crystals, comparable to potassium citrate, highlights the churna's antiurolithiatic efficacy, likely due to Moringa's diuretic properties and Coriander's ability to inhibit crystal nucleation ^[19]. Its function in kidney stone prevention is further supported by in vivo decreases in urine calcium and oxalate. Scalability and clinical connection are supported by the safe profile (no toxin up to 2000 mg/kg) and respectable inflow parcels (Carr's Index 20.45)^[20]. Compared to individual herbs, the polyherbal formulation exhibited synergistic effects, as the combination of antioxidant, anti-inflammatory, and diuretic mechanisms likely enhanced therapeutic outcomes. However, limitations include the need for clinical trials to confirm efficacy in humans and detailed mechanistic studies to elucidate specific pathways (e.g., PPAR- γ activation for antidiabetic effects or crystal dissolution kinetics).

5. Future Perspectives

- 1) The promising results of this study open several avenues for future research and development.
- 2) Clinical Trials.
- 3) Mechanistic Studies.
- 4) Formulation Optimization.
- 5) Synergistic Interactions.
- 6) Pharmacokinetic Studies.
- 7) Regulatory Approvals.
- 8) Global Market Potential.
- 9) Personalized Medicine.

6. CONCLUSION

The polyherbal churna, comprising Amla, Hirada, Behada, Moringa, and Coriander, demonstrated significant antidiabetic (IC₅₀: 120 µg/mL, 35% glucose reduction) and antiurolithiatic (45% crystal dissolution) potential, supported by a rich phytochemical profile and favorable physicochemical and pharmaceutical properties. The formulation's safety, confirmed through toxicity studies, and its synergistic effects make it a promising candidate for further pharmacological and clinical development. This study highlights the potential of Ayurvedic polyherbal formulations in addressing complex metabolic and urological disorders, paving the way for integrative therapeutic approaches.

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