

## Formulation and Evaluation of Polyherbal Anti-Diabetic Tea Bags

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### ABSTRACT

**Background:** Diabetes mellitus is a global metabolic disorder with rising prevalence. Ayurveda offers a rich repository of anti-diabetic herbs acting through multiple pathways. The present study aimed at formulating a novel polyherbal tea bag using five classical herbs — Nisha (*Berberis aristata*), Amalaki (*Emblica officinalis*), Nagara (*Zingiber officinale*), Ela (*Elettaria cardamomum*), and Twak (*Cinnamomum zeylanicum*) — known for Pramehaghna and Deepana-Pachana properties.

**Methods:** The tea bag was prepared using standardised pharmaceutical procedures. Analytical parameters including pH, loss on drying, total ash, acid insoluble ash, water and alcohol soluble extractives, bulk density, and tap density were evaluated. An Alpha Amylase Enzyme Inhibition Assay was performed at 20%, 40%, 60%, and 80% extract concentrations at 5, 10, and 15-minute intervals.

**Results:** Analytical evaluation confirmed pharmaceutical quality with pH 4.02 at 5% concentration. Alpha Amylase inhibition showed a dose- and time-dependent increase from 12.76% (20%, 5 min) to 37.43% (80%, 15 min). Percentage yield was 67.14% with a loss of 32.86% (115 g) from a total input of 350 g.

**Conclusion:** The polyherbal anti-diabetic tea bag demonstrated acceptable physicochemical parameters and efficient Alpha Amylase inhibitory activity, validating its potential as a nutraceutical dosage form bridging classical Phanta Kalpana with modern pharmaceutical delivery.

**Keywords:** Polyherbal Tea Bag, Phanta Kalpana, Pramehaghna, Alpha Amylase Inhibition, Nisha, Amalaki, Anti-diabetic, Ayurveda

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### I. INTRODUCTION

Diabetes mellitus is a chronic metabolic disorder characterised by persistent hyperglycaemia. With over 537 million adults affected worldwide, it represents one of the most pressing global health challenges of the 21st century.<sup>1</sup> In Ayurveda, this condition is classified under Prameha and Madhumeha, and a vast pharmacopoeia of anti-diabetic herbs has been documented across classical texts including Charaka Samhita, Sushruta Samhita, and Ashtanga Hridayam. Ayurveda emphasises disease management as well as preventive healthcare through dietary and lifestyle modifications. Novel Ayurvedic formulations combining traditional knowledge with modern pharmaceutical science are gaining global attention.<sup>2</sup> Herbal tea bags represent a practical, accessible, and culturally acceptable vehicle for delivering therapeutic benefits in a patient-friendly format.

#### Phanta Kalpana — Classical Background

Phanta Kalpana is one of the Panchavidha Kashaya Kalpana (five classical pharmaceutical preparations) described in Sharangadhara Samhita<sup>3</sup> (Madhyama Khanda, Chapter 2). It involves preparation of a hot

infusion by adding boiling water to the coarse powder of the drug and allowing it to steep for a prescribed duration. Unlike Kwatha (decoction), which involves prolonged boiling, Phanta preserves thermolabile phytoconstituents and volatile active principles. This classical method forms the conceptual basis for the modern herbal tea bag — a convenient, unit-dose adaptation of the same principle.

#### Modern Tea Bag Preparation

The modern herbal tea bag is a unit-dose pharmaceutical preparation where a measured quantity of coarsely powdered herbal material is enclosed within a porous, heat-sealable filter paper pouch. When immersed in hot water, the bag allows diffusion of phytochemical constituents into the liquid, mimicking the Phanta process. Tea bag technology enables dose standardisation, ensures hygiene, prevents contamination, and improves patient compliance.<sup>4</sup> Key quality parameters include bulk density, tap density, loss on drying, and extractive values as per API<sup>5</sup> and AFI<sup>6</sup> guidelines.

### Herbs Selected and Their Rationale

The five herbs were selected based on their documented Pramehaghna, Deepana, and Pachana activities in classical Ayurvedic texts as well as modern pharmacological evidence:

- Nisha (*Berberis aristata* DC.) — Tikta Rasa, Laghu-Ruksha Guna; berberine is a potent alpha-glucosidase inhibitor with established hypoglycaemic activity.<sup>7</sup>
- Amalaki (*Emblica officinalis* Gaertn.) — Amla Rasa Pradhana, Rasayana; rich in polyphenols, improves insulin sensitivity and reduces oxidative stress.<sup>8</sup>
- Nagara (*Zingiber officinale* Rosc.) — Katu Rasa, Ushna Veerya; gingerols enhance glucose uptake and inhibit digestive enzymes.<sup>11</sup>
- Ela (*Elettaria cardamomum* Maton.) — aromatic, improves gastrointestinal motility and has documented anti-glycation properties.<sup>12</sup>
- Twak (*Cinnamomum zeylanicum* Blume.) — Katu-Tikta Rasa, Ushna Veerya; cinnamaldehyde improves insulin receptor sensitivity and inhibits alpha-amylase.<sup>9</sup>

### II. AIM

To formulate a polyherbal anti-diabetic tea bag using five classical Ayurvedic herbs — Nisha, Amalaki, Nagara, Ela, and Twak — and to evaluate its physicochemical properties and alpha-amylase enzyme inhibitory activity to establish its pharmaceutical quality and therapeutic potential.

### III. OBJECTIVES

- To pharmaceutically prepare the polyherbal anti-diabetic tea bag using standardised drug materials.
- To perform analytical evaluation including pH, loss on drying, total ash, acid insoluble ash, water and alcohol soluble extractive values, bulk density, tap density, and percentage yield.
- To conduct an Alpha Amylase Enzyme Inhibition Assay using different extract concentrations at varying time intervals to assess anti-diabetic potential.
- To correlate analytical and enzymatic findings with the classical Ayurvedic understanding of Pramehaghna activity.

### IV. MATERIALS AND METHODS

#### 4.1 Drug Materials

All five herbs were procured from Alva's Ayurvedic Pharmacy, Mijar. Botanical identity was confirmed by a qualified pharmacognosist. Drugs were cleaned, dried, and coarsely powdered using mesh no. 20–40.

Sl .	Drug	Botanical Name	Part Used	Reference
1	Nisha	<i>Berberis aristata</i> DC.	Rhizome	Kaiyadeva Nighantu <sup>2</sup>
2	Amalaki	<i>Emblica officinalis</i> Gaertn.	Fruit	Bhavaprakasha Nighantu <sup>3</sup>
3	Nagara	<i>Zingiber officinale</i> Rosc.	Rhizome	Sharangadhara Samhita <sup>1</sup>
4	Ela	<i>Elettaria cardamomum</i> Maton.	Seeds	Bhavaprakasha Nighantu <sup>3</sup>
5	Twak	<i>Cinnamomum zeylanicum</i> Blume.	Stem bark	Kaiyadeva Nighantu <sup>2</sup>

Table 1: Drug Materials Used

#### 4.2 Equipment and Instruments

- Mechanical grinder and mesh sieves (No. 20 and 40)
- Analytical balance (accuracy 0.001 g)
- pH meter (calibrated with standard buffers)
- Hot air oven (for loss on drying at 105°C)
- Muffle furnace (for ash values at 600°C)
- Soxhlet apparatus (for extractive values)
- Measuring cylinders (10 mL, 25 mL, 100 mL) and volumetric flasks
- Porcelain crucibles and desiccator
- Mortar and pestle
- Digital weighing balance
- Heat-sealable filter paper pouches (food-grade, 65 gsm, non-woven)
- Impulse sealer / hand-operated tea bag sealer
- UV-Visible Spectrophotometer (for amylase assay at 540 nm)
- Water bath and incubator (maintained at 37°C)
- Micropipettes (100 µL, 1000 µL) and test tubes
- Refrigerator (for storage of enzyme and reagents)

#### 4.3 Pharmaceutical Preparation of Tea Bag

##### 4.3a Poorvakarma (Preparatory Steps)

- Each drug was cleaned to remove foreign matter and dried at 60°C to constant weight.
- Each herb was coarsely powdered and passed through mesh no. 40 for uniform particle size.
- Powders were stored individually in airtight, labelled containers.

#### 4.3b Pradhana Karma — Drug Proportions (Total input: 350 g)

Sl.	Drug	Proportion	Weight (g)
1	Nisha	1.5 parts	100 g
2	Amalaki	1.5 parts	100 g
3	Nagara	1 part	50 g
4	Ela	1 part	50 g
5	Twak	1 part	50 g
	Total	6 parts	350 g

Table 2: Drug Proportions (Total Input: 350 g)

- Powders were weighed accurately and blended together by uniform mixing to ensure homogeneity.
- Blended polyherbal powder (3 g per unit) was filled into heat-sealable filter paper pouches and sealed airtight using an impulse sealer.
- Each bag was labelled and packed in moisture-proof outer packaging.

#### 4.3c Paschat Karma (Post-preparatory Steps)

- Organoleptic evaluation was recorded immediately after preparation.
- Samples were stored in a cool, dry place away from direct sunlight.
- Yield: Total input — 350 g; Yield obtained — 235 g (after filling and sealing losses).
- Usage instruction: One tea bag steeped in 150 mL of freshly boiled water for 5–10 minutes, consumed twice daily before food.

#### 4.4 Analytical Evaluation Parameters

Analytical evaluation was conducted at Amrith Labs, Nisargam Private Limited, Shimoga (NABL Accredited and AYUSH Approved Laboratory, Report No. ALO2526393, dated 02-02-2026) as per API<sup>5</sup> and AFI<sup>6</sup> guidelines:

- pH @5%: Calibrated digital pH meter; 5% w/v aqueous solution.
- Loss on Drying: Heated at 105°C to constant weight.
- Total Ash: Incineration at 600°C in muffle furnace.
- Acid Insoluble Ash: Total ash treated with dilute HCl; insoluble residue.
- Water Soluble Extractive: Cold maceration in 100 mL water, evaporated to dryness.
- Alcohol Soluble Extractive: Same procedure using 90% ethanol.

- Bulk Density: Mass divided by untapped volume.
- Tap Density: Mass divided by tapped volume after standardised tapping.

#### 4.5 Alpha Amylase Enzyme Inhibition Assay

##### Principle

Alpha-amylase catalyses the hydrolysis of starch into maltose and glucose.<sup>13</sup> Inhibition delays carbohydrate digestion and reduces postprandial blood glucose. The extent of inhibition is measured spectrophotometrically using the dinitrosalicylic acid (DNS) method, where reducing sugars released are quantified. Acarbose is used as the standard inhibitor.

##### Procedure

Aqueous extracts of the tea bag were prepared at four concentrations: 20%, 40%, 60%, and 80% (dry weight basis). Each was incubated with alpha-amylase enzyme (0.5 mg/mL in 0.02 M sodium phosphate buffer, pH 6.9 with 0.006 M NaCl) at 37°C for 5, 10, and 15 minutes.<sup>13</sup> Substrate (1% starch) was added, the reaction terminated using DNS reagent, and absorbance measured at 540 nm. Percentage inhibition was calculated as:

$$\% \text{ Inhibition} = \frac{[\text{Absorbance of Control} - \text{Absorbance of Sample}]}{\text{Absorbance of Control}} \times 100$$

## V. RESULTS AND OBSERVATIONS

#### 5.1 Organoleptic Observations

Sl.	Parameter	Observation
1	Colour	Yellowish brown to dark brown
2	Odour	Characteristic aromatic, pungent
3	Taste	Astringent with sweet after-taste
4	Texture	Coarse granular powder
5	Consistency	Free flowing, non-hygroscopic
6	Infusion colour	Deep amber to reddish-brown

Table 3: Organoleptic Observations

#### 5.2 Analytical Results

Analytical evaluation conducted at Amrith Labs (NABL Accredited, AYUSH Approved, Report No. ALO2526393, 02-02-2026) as per API<sup>5</sup> and AFI<sup>6</sup> standards:

Sl.	Parameter	Unit	Results
1	pH @5%	—	4.02
2	Loss on Drying	%	12.45
3	Total Ash	%	5.81
4	Acid Insoluble Ash	%	4.33
5	Water Soluble Extractive	%	15.95
6	Alcohol Soluble Extractive	%	7.06
7	Tap Density	g/mL	0.593
8	Bulk Density	g/mL	0.532

Table 4: Analytical Results of Polyherbal Anti-Diabetic Tea Bag

### 5.3 Percentage Yield and Loss

Sl.	Parameter	Value (%)	Value (g)
1	Total Input	100%	350 g
2	Yield Obtained	67.14%	235 g
3	Loss (Processing)	32.86%	115 g

Table 5: Percentage Yield and Loss

### 5.4 Alpha Amylase Enzyme Inhibition Assay Results

Sl.	Alpha Amylase Assay	Unit	% Inhibition
1	20% (dry basis) – 5 min	%	12.76
2	20% (dry basis) – 10 min	%	14.33
3	20% (dry basis) – 15 min	%	14.81
4	40% (dry basis) – 5 min	%	15.66
5	40% (dry basis) – 10 min	%	17.93
6	40% (dry basis) – 15 min	%	18.72
7	60% (dry basis) – 5 min	%	26.99
8	60% (dry basis) – 10 min	%	27.36
9	60% (dry basis) – 15 min	%	28.93
10	80% (dry basis) – 5 min	%	28.76
11	80% (dry basis) – 10 min	%	34.88
12	80% (dry basis) – 15 min	%	37.43

Table 6: Alpha Amylase Inhibition Assay Results (% Inhibition)

## VI. DISCUSSION

### 6.1 Discussion on Role of Ingredients

- Nisha (*Berberis aristata*): The primary active constituent berberine acts as a potent alpha-glucosidase and alpha-amylase inhibitor.<sup>7</sup> Its Tikta Rasa and Laghu-Ruksha Guna create an unfavourable environment for Kapha-Medo accumulation, directly addressing the Dosha basis of Prameha.<sup>2</sup> Berberine also activates AMPK pathways, improving glucose uptake at the cellular level.
- Amalaki (*Embllica officinalis*): Rich in gallic acid, ellagic acid, and ascorbic acid, Amalaki contributes significantly to the acidic pH of the formulation (pH 4.02).<sup>8</sup> Its Rasayana property supports pancreatic beta-cell preservation and reduces oxidative stress.<sup>3</sup> The polyphenolic content competitively inhibits digestive enzymes.
- Nagara (*Zingiber officinale*): Gingerols and shogaols enhance glucose uptake and inhibit alpha-amylase.<sup>11</sup> Its Ushna Veerya and Deepana property improve digestive fire (Agni), supporting the metabolic correction of Prameha.<sup>1</sup>
- Ela (*Elettaria cardamomum*): Aromatic volatile oils and flavonoids contribute to pleasant infusion characteristics while providing anti-glycation and gastrointestinal motility-enhancing effects,<sup>12</sup> complementing the Pachana activity of the formulation.<sup>3</sup>
- Twak (*Cinnamomum zeylanicum*): Cinnamaldehyde and procyanidins are well-established alpha-amylase inhibitors.<sup>9</sup> Twak improves insulin receptor sensitivity and provides antioxidant support. Its Katu-Tikta Rasa and Ushna Veerya enhance Kapha Shamana activity.<sup>2</sup>

### 6.2 Discussion on Pharmaceutical Study

- Faithful pharmaceutical preparation: The entire process was carried out in strict adherence to classical Phanta Kalpana principles<sup>3</sup> — coarse powder, hot infusion — adapted into a modern tea bag format. Selection of mesh no. 40 ensured optimal particle size for extraction efficiency without bag rupture.
- Quality of the preparation: The infusion produced upon steeping showed a rich amber-brown colour with characteristic astringent taste and sweet after-taste, confirming adequate

extraction of active phytoconstituents. Uniform sealing of pouches was verified and no powder leakage was observed.

- **Pharmaceutical validity:** The tea bag format ensures unit-dose standardisation, reproducibility, and patient compliance<sup>4</sup> — characteristics that directly address the practical limitations of classical Phanta Kalpana in modern clinical settings.
- **Yield:** A total input of 350 g yielded 235 g of the final formulation (67.14%), with a processing loss of 115 g (32.86%). The loss is attributed to powder adhesion to vessel walls, sieving losses, and sealing waste — consistent with expected losses in herbal tea bag manufacturing.

### 6.3 Discussion on Analytical Results

- **pH (4.02 at 5%):** The acidic pH is primarily attributed to Amalaki<sup>8</sup> and Nisha. This range inhibits pathogenic microbial growth and may enhance bioavailability of polyphenolic compounds.
- **Loss on Drying (12.45%):** Within acceptable API<sup>5</sup> limits, indicating adequate moisture control. Controlled moisture prevents fungal contamination and degradation of active constituents.
- **Total Ash (5.81%) and Acid Insoluble Ash (4.33%):** Confirm absence of excessive inorganic impurities within API<sup>5</sup> reference ranges. The acid insoluble ash reflects the inherent silica content of Nisha root bark.
- **Water Soluble Extractive (15.95%):** A high value confirming significant water-soluble polyphenols, flavonoids, and alkaloids effectively extracted upon steeping — validating the Phanta-based delivery system.<sup>6</sup>
- **Alcohol Soluble Extractive (7.06%):** Reflects the lipophilic fraction including essential oils and terpenoids contributing to the overall therapeutic profile.<sup>10</sup>
- **Bulk (0.532 g/mL) and Tap Density (0.593 g/mL):** Carr's Index of 10.28% falls in the 'excellent' flowability category (USP<sup>10</sup>), confirming suitability for tea bag filling operations.

### 6.4 Discussion on Alpha Amylase Inhibition Assay

The Alpha Amylase Inhibition Assay<sup>13</sup> demonstrated a clear dose-dependent and time-dependent pattern. Inhibition increased from 12.76% at the lowest concentration (20%, 5 min) to a maximum of 37.43% at 80% extract over 15 minutes. This pattern is consistent with classical enzyme inhibition kinetics

and reflects the efficient anti-diabetic potential of the formulation.

The primary contributors include berberine<sup>7</sup> (Nisha), cinnamaldehyde and procyanidins<sup>9</sup> (Twak), gallic and ellagic acids<sup>8</sup> (Amalaki), gingerols<sup>11</sup> (Nagara), and flavonoids<sup>12</sup> (Ela). The progressive increase in inhibition with time suggests sustained release of active constituents, pharmacokinetically desirable for postprandial glycaemic control.

The formulation demonstrated efficient inhibitory activity consistent with its multi-constituent polyphenolic and alkaloid profile. Beyond enzyme inhibition, the formulation's anti-diabetic benefit encompasses insulin sensitisation, antioxidant activity, and Agni-enhancing properties<sup>1,2,3</sup> — consistent with the classical Pramehaghna mechanism of Tikta-Kashaya Rasa dominance and Kapha-Medo-Dushti Shamana.

## VII. CONCLUSION

The polyherbal anti-diabetic tea bag was successfully formulated using five classical Pramehaghna herbs — Nisha, Amalaki, Nagara, Ela, and Twak — procured from Alva Pharmacy, Mijar. The formulation demonstrated acceptable physicochemical parameters — pH 4.02, loss on drying 12.45%, total ash 5.81%, water soluble extractive 15.95%, bulk density 0.532 g/mL, and tap density 0.593 g/mL<sup>5,6</sup> — confirming pharmaceutical quality and stability.

A total input of 350 g yielded 235 g (67.14%) of the finished formulation. Alpha Amylase Inhibition Assay<sup>13</sup> revealed efficient dose-dependent inhibitory activity up to 37.43%, validating anti-diabetic potential through enzymatic inhibition of carbohydrate digestion.

This modern adaptation of Phanta Kalpana<sup>3</sup> into a standardised tea bag represents a significant advancement in Ayurvedic dosage form development, combining classical pharmaceutical wisdom with modern convenience and precision. The formulation holds promise as a nutraceutical adjunct for Type 2 Diabetes Mellitus management and warrants further investigation through in vivo studies, clinical trials, and long-term stability evaluation.

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### IX. PHOTOGRAPHS SHOWING TEABAG PREPARATION



Ingredients



Process of Pounding



Sieving



After sieving



Addition of drugs one by one



Blending homogeneously



Tying pouch & zip lock packaging



Process of weighing



Filling in tea bag pouches