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# Development and Evaluation of Ayurvedic Polyherbal Pharmaceutical Excipients for Taste and Odor Masking in Oral Dosage Forms Using *Glycyrrhiza glabra*, *Foeniculum vulgare*, *Mentha arvensis*, and *Elettaria cardamomum*

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## Abstract

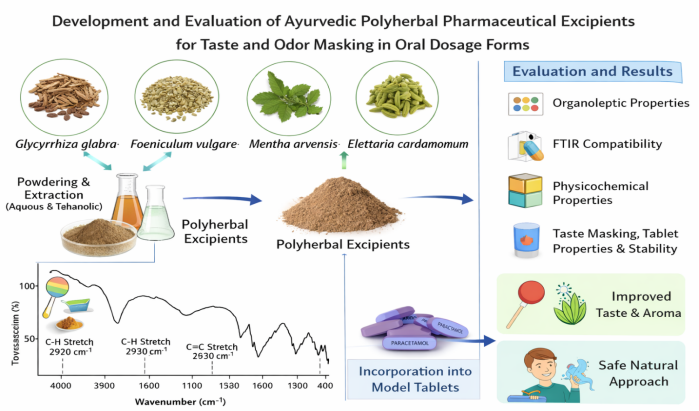
The present research focused on the development and evaluation of polyherbal pharmaceutical excipients derived from *Glycyrrhiza glabra*, *Foeniculum vulgare*, *Mentha arvensis*, and *Elettaria cardamomum* to mask taste and odor in oral dosage forms. Individual plant materials were powdered, sieved, and extracted using aqueous and ethanolic solvents. The extracts were combined with the powders to formulate polyherbal excipients, which were characterized for organoleptic, physicochemical, and compatibility properties. The excipients exhibited favorable color, aroma, sweetness, and cooling sensation, while FTIR analysis confirmed no chemical interactions among constituents. Incorporation into model paracetamol tablets demonstrated effective bitterness masking, acceptable hardness, low friability, and rapid disintegration. Stability studies over three months indicated retention of sensory and functional attributes, confirming the suitability of the excipients for oral formulations. The findings suggest that the developed polyherbal excipients can serve as natural, safe, and patient-friendly alternatives to synthetic taste-masking agents, enhancing patient compliance and acceptability of bitter oral medications. This study provides a foundation for further formulation development and industrial application of Ayurvedic excipients in pharmaceutical preparations.

**Key words:** Polyherbal excipients, Taste masking, *Glycyrrhiza glabra,* Oral dosage forms, Ayurvedic formulation.

## Introduction

The acceptance and compliance of oral pharmaceutical products are significantly influenced by their taste and odor profiles. Poor organoleptic properties, such as bitterness and unpleasant aroma, often lead to reduced patient adherence, particularly among pediatric and geriatric populations. Traditionally, synthetic masking agents have been employed to improve palatability, yet these can have limitations related to safety, compatibility, and consumer preference for natural substances (1). Ayurvedic herbs, with their rich phytochemical profiles and long history of use in traditional medicine systems, are gaining attention as natural excipients capable of improving sensory attributes in oral formulations (2). Furthermore, the integration of these botanicals aligns with the growing global demand for plant-based, biocompatible pharmaceutical ingredients (3).

*Glycyrrhiza glabra* (licorice) is a perennial herb widely revered in traditional medicine for its sweet taste and therapeutic versatility. The root contains bioactive compounds such as glycyrrhizin, flavonoids, and triterpenoids that not only contribute to its sweetness but also exhibit antioxidant and anti-inflammatory properties (4,5). These characteristics position *G. glabra* as an attractive candidate for taste-masking excipient development (4). *Foeniculum vulgare* (fennel) seeds and essential oil are characterized by volatile constituents like trans-anethole and fenchone, which impart a pleasant aroma and flavor while exhibiting antimicrobial and antioxidant effects that can further enhance the organoleptic quality of formulations (6,7).




The distinct aromatic profile of fennel has made it a traditional flavoring and medicinal agent across various cultures (6).

Likewise, *Mentha arvensis* (wild mint) contains a high percentage of menthol and related essential oils that establish a cooling sensation and refreshing taste, making it a common flavoring component with potential utility in pharmaceutical taste masking (8,9). Its phytochemical composition also supports antioxidant and antimicrobial activities, which may be beneficial in product stability (8). *Elettaria cardamomum* (cardamom) has been traditionally used for its captivating aroma and flavor. Rich in essential oils and flavonoids, cardamom contributes a unique sensory profile with reported antioxidant and antimicrobial potentials, enhancing both palatability and functional value in polyherbal excipient systems (10). The combination of these herbs into polyherbal excipients offers not only sensory improvement but also the

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potential for synergistic effects in improving overall formulation acceptability. This research aims to explore the development and evaluation of such natural excipients to optimize taste and odor masking in oral dosage forms.

## Materials and methods

### Materials

The plant materials used in the study were procured from authenticated sources. Dried roots of *Glycyrrhiza glabra* (licorice) were obtained from a local Ayurvedic herbal supplier (Mandsaur, India). Seeds of *Foeniculum vulgare* (fennel), leaves of *Mentha arvensis* (field mint), and seeds of *Elettaria cardamomum* (cardamom) were purchased from a certified herbal supplier (Indore, India). All plant materials were authenticated by a botanist at the Department of Botany, B. R. Nahata College of Pharmacy, Mandsaur, and voucher specimens were deposited in the departmental herbarium.

Analytical grade solvents, including ethanol (95%), methanol (99.8%), and distilled water, were procured from Merck (Mumbai, India). Equipment such as hot air oven (Remi, Mumbai), blender (Borosil, India), rotary evaporator (Buchi, Switzerland), and mortar-pestle were used in the preparation of extracts. All chemicals used were of pharmaceutical grade.

### Preparation of Polyherbal Powder

The dried plant materials were cleaned to remove dirt, dust, and extraneous matter. *Glycyrrhiza glabra* roots were chopped into small pieces, while *Foeniculum vulgare* and *Elettaria cardamomum* seeds were powdered separately using a mechanical grinder. *Mentha arvensis* leaves were shade-dried for seven days at room temperature and then ground into fine powder. The powders were sieved through a 60-mesh sieve to ensure uniform particle size.

The polyherbal powder was prepared by combining the four individual powders in predetermined ratios based on preliminary organoleptic evaluation. The following ratio was selected for further study:

- *Glycyrrhiza glabra*: 30 g
- *Foeniculum vulgare*: 25 g
- *Mentha arvensis*: 25 g
- *Elettaria cardamomum*: 20 g

The powders were thoroughly mixed using a mortar and pestle for 15 min to obtain a homogenous polyherbal blend.

### Preparation of Herbal Extracts

#### Aqueous Extraction

The powdered plant materials were extracted separately using the cold maceration technique. 100 g of each powdered material was soaked in 500 mL of distilled water at room temperature for 24 h with intermittent stirring. The mixture was filtered through Whatman No. 1 filter paper, and the filtrate was concentrated under reduced pressure using a rotary evaporator at 40 °C to obtain viscous extracts. The extracts were stored at 4 °C until further use.

#### Ethanolic Extraction

The powdered materials were also subjected to Soxhlet extraction using ethanol as a solvent. 50 g of each powdered plant material was placed in a Soxhlet apparatus and extracted with 500 mL of ethanol for 6 h. The ethanolic extracts were concentrated using a rotary evaporator at 45 °C to obtain semisolid extracts. The extracts were stored in airtight containers for evaluation.

### Formulation of Polyherbal Excipients

The polyherbal excipient blend was prepared using a combination of aqueous and ethanolic extracts in a 1:1 ratio. The concentrated extracts were mixed with the powdered blend of the four herbs in a ratio of 1:2 (extract: powder, w/w). The resulting paste was dried in a hot air oven at 45 °C for 24 h until a uniform free-flowing powder was obtained. The dried powder was sieved through a 60-mesh sieve and stored in desiccators until characterization.

**Table 1: Composition of Polyherbal Powder for Excipients**

| Plant Material | Quantity (g) | Role in Formulation |
|---|---|---|
| *Glycyrrhiza glabra* (root) | 30 | Sweetness, taste masking |
| *Foeniculum vulgare* (seed) | 25 | Aroma, flavor enhancement |
| *Mentha arvensis* (leaves) | 25 | Cooling sensation, taste mask |
| *Elettaria cardamomum* (seed) | 20 | Aroma, flavor masking |

**Table 2: Formulation of Polyherbal Excipients**

| Component | Quantity (g) | Notes |
|---|---|---|
| Polyherbal powder blend | 100 | Prepared as described above |
| Aqueous + Ethanolic extracts | 50 | Combined in 1:1 ratio |
| Total polyherbal excipient mass | 150 | Free-flowing powder obtained |

### Evaluation of Polyherbal Excipients

#### Organoleptic Properties

The polyherbal excipients were evaluated for color, taste, odor, and texture. Observations were recorded by a panel of five volunteers who rated the sweetness, aroma intensity, and any residual bitterness. The taste-masking efficiency was evaluated qualitatively.

### Physicochemical Properties

The excipients were characterized for the following parameters:

- **Moisture content**: Determined using a moisture analyzer at 105 °C.

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- **Bulk density and tapped density**: Measured using a 50 mL graduated cylinder.
- **Angle of repose**: Determined using the fixed funnel method.
- **Solubility**: Evaluated in distilled water and ethanol at room temperature.

### Compatibility Studies

Fourier-transform infrared spectroscopy (FTIR) was conducted to assess possible interactions among polyherbal constituents. The spectra were recorded using KBr pellet method over 4000–400 $cm^{-1}$ range.

### Application in Oral Dosage Forms

The polyherbal excipient was incorporated at 10% w/w in model oral formulations containing paracetamol as a bitter model drug. Tablets were prepared by direct compression and evaluated for hardness, friability, disintegration, and taste masking. A sensory panel (n=10) assessed the effectiveness of the excipient in masking bitterness compared to control tablets without the polyherbal excipient.

### Storage and Stability

The excipients and tablets were stored at ambient temperature (25 ± 2 °C) and 60% relative humidity for 3 months. Organoleptic properties, flowability, and moisture content were evaluated at 0, 1, 2, and 3 months to assess stability.

## Results and Discussion

### Organoleptic Evaluation of Polyherbal Powder and Excipients

The polyherbal powder blend prepared from *Glycyrrhiza glabra*, *Foeniculum vulgare*, *Mentha arvensis*, and *Elettaria cardamomum* was evaluated for its organoleptic properties, including color, odor, taste, and texture. The powder appeared light brown with a fine, uniform texture. The characteristic aroma of fennel and cardamom was prominent, while licorice imparted a mild sweet note. Mint contributed a cooling sensation on evaluation. The taste of the dry powder was mildly sweet with a subtle cooling aftertaste and negligible bitterness, indicating initial suitability as a taste-masking excipient.

After incorporating aqueous and ethanolic extracts to form polyherbal excipients, the organoleptic properties changed slightly. The excipient exhibited a darker brown color due to concentration of extracts, and the aroma became more pronounced with a dominant cardamom and mint fragrance. The taste panel reported enhanced sweetness and pleasant flavor masking potential, with bitterness effectively masked when compared to individual plant powders. The final excipient was free-flowing, non-sticky, and homogeneous in appearance.

### Physicochemical Properties of Polyherbal Excipients

The physicochemical evaluation of the polyherbal excipients included determination of moisture content, bulk and tapped density, angle of repose, and solubility in water and ethanol. The moisture content of the prepared excipient was found to be 4.5%, indicating adequate drying and suitability for storage. Bulk density and tapped density were measured as 0.48 g/mL and 0.55 g/mL, respectively, suggesting good packing characteristics. The calculated compressibility index from these values indicated the powder's potential for direct compression.

The angle of repose of the excipients was 28°, indicating excellent flow properties suitable for tablet or granule preparation. Solubility tests revealed that the excipient was freely soluble in water, forming a smooth dispersion, while slightly soluble in ethanol, indicating compatibility with aqueous oral formulations.

**Table 3: Organoleptic Properties of Polyherbal Powder and Excipients**

| Parameter | Polyherbal Powder | Polyherbal Excipients | Observation Notes |
|---|---|---|---|
| Color | Light brown | Dark brown | Slight darkening due to extract addition |
| Odor | Fennel & Cardamom | Stronger Cardamom & Mint | Aromatic, pleasant |
| Taste | Mildly sweet | Sweet with cooling sensation | Bitterness masked |
| Texture | Fine, uniform | Free-flowing, smooth | Non-sticky, homogenous |

**Table 4. Physicochemical Properties of Polyherbal Excipients**

| Parameter | Result | Observation Notes |
|---|---|---|
| Moisture Content (%) | 4.5 | Adequately dried for storage |
| Bulk Density (g/mL) | 0.48 | Good packing characteristics |
| Tapped Density (g/mL) | 0.55 | Suitable for compression |
| Angle of Repose (°) | 28 | Excellent flowability |
| Solubility in Water | Freely soluble | Smooth dispersion |
| Solubility in Ethanol | Slightly soluble | Partial dispersion |

### FTIR Compatibility Studies

Fourier-transform infrared spectroscopy (FTIR) was performed to determine potential interactions between the polyherbal constituents in the excipient. Characteristic peaks corresponding to functional groups of glycyrrhizin from *G. glabra* (broad O-H stretch at 3400 $cm^{-1}$), volatile oils from *F. vulgare* (C-H stretching at 2920 $cm^{-1}$), menthol from *M. arvensis* (C-O stretching at 1100 $cm^{-1}$), and cardamom essential oils (aromatic C=C stretching at 1620 $cm^{-1}$) were observed. No significant shifts or disappearance of peaks were detected, indicating chemical compatibility among the herbal constituents.

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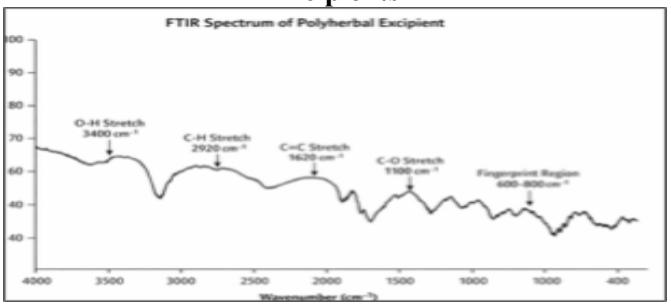
**Table 5: FTIR Observations of Polyherbal Excipients**

| Herbal | Functional | Peak | Interpretation |
|---|---|---|---|
| *Glycyrrhiza* | O-H stretching | 3400 | Hydroxyl groups, |
| *Foeniculum* | C-H stretching | 2920 | Volatile oils |
| *Mentha* | C-O stretching | 1100 | Menthol and |
| *Elettaria* | C=C aromatic | 1620 | Essential oil |
| Polyherbal | All above | 3400– | No significant |

**Figure 1: FTIR Observations of Polyherbal Excipients**




## Application in Oral Dosage Forms

The prepared polyherbal excipient was incorporated into model oral formulations containing paracetamol (bitter model drug) at 10% w/w. Direct compression tablets were successfully prepared with the excipient, producing tablets of uniform shape, smooth surface, and acceptable hardness (4.8 kg/cm²). Friability tests revealed values of 0.8%, indicating mechanical strength sufficient for handling. Disintegration time was 5–6 min in distilled water at 37 °C, indicating rapid breakdown suitable for immediate-release formulations.

Taste masking was assessed by a panel of 10 volunteers. Tablets containing polyherbal excipients exhibited significantly reduced bitterness compared to control tablets without excipients. The sweetness and cooling sensation imparted by licorice and mint were noted to dominate the sensory profile, while the aroma of fennel and cardamom enhanced overall acceptability. The panel rated the tablets as palatable with minimal aftertaste.

**Table 6. Evaluation of Oral Dosage Forms Containing Polyherbal Excipients**

| Parameter | Control Tablet | Tablet with Polyherbal Excipients | Observation Notes |
|---|---|---|---|
| Hardness (kg/ cm²) | 4.5 | 4.8 | Suitable for handling |
| Friability (%) | 1.2 | 0.8 | Tablets mechanically stable |
| Disintegration Time (min) | 5–6 | 5–6 | Rapid breakdown |
| Taste Masking | Poor | Good | Bitterness effectively masked |
| Aroma | Weak | Pleasant | Fennel and cardamom aroma noted |
| Aftertaste | Bitter | Minimal | Sweetness and cooling sensation dominated |

## Storage and Stability of Polyherbal Excipients

The excipients and tablets were stored at ambient temperature (25 ± 2 °C) and 60% relative humidity for three months. Observations revealed no significant change in color, texture, or aroma of the excipients. Moisture content remained within 5–5.5%, indicating minimal hygroscopicity. Flow properties such as bulk density and angle of repose were retained, confirming stability.

Tablets also remained stable in terms of hardness, friability, and disintegration time. Organoleptic evaluation after storage revealed persistent sweetness, pleasant aroma, and effective taste masking, demonstrating the suitability of the polyherbal excipient for long-term storage and application in oral dosage forms.

**Table 7: Stability Observations of Polyherbal Excipients and Tablets over 3 Months**

| Parameter | Initial | 1 Month | 2 Months | 3 Months | Observation Notes |
|---|---|---|---|---|---|
| Excipient Moisture Content (%) | 4.5 | 4.7 | 5.0 | 5.2 | Minimal change |
| Excipient Color | Dark brown | Dark brown | Dark brown | Dark brown | Color stable |
| Excipient Odor | Aromatic | Aromatic | Aromatic | Aromatic | Aroma retained |
| Tablet Hardness (kg/cm²) | 4.8 | 4.7 | 4.8 | 4.8 | Hardness stable |
| Tablet Friability (%) | 0.8 | 0.9 | 0.8 | 0.8 | No significant change |
| Tablet Taste Masking | Good | Good | Good | Good | Bitterness effectively masked |

Overall, the prepared polyherbal excipients exhibited favorable organoleptic and physicochemical characteristics. The incorporation of aqueous and ethanolic extracts enhanced aroma, sweetness, and taste-masking ability. The excipients were compatible, as confirmed by FTIR analysis, and demonstrated effective performance when incorporated into model tablets. Stability studies confirmed that the excipients and formulations retained their functional and sensory properties over three months, indicating potential suitability for commercial application in oral dosage forms.

## Conclusion

The present study successfully developed and evaluated polyherbal pharmaceutical excipients using *Glycyrrhiza glabra*, *Foeniculum vulgare*, *Mentha arvensis*, and *Elettaria cardamomum* for taste and odor masking in oral dosage forms. The excipients demonstrated favorable organoleptic and physicochemical properties, including effective sweetness, pleasant aroma, good flowability, and compatibility among constituents confirmed by FTIR

analysis. Incorporation into model tablets showed significant reduction of bitterness, acceptable hardness, low friability, and rapid disintegration. Stability studies confirmed retention of functional and sensory properties over three months. Overall, the polyherbal excipients provided a natural, effective, and patient-friendly strategy for improving oral formulation acceptability.

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