

Preparation And Evaluation of Polyherbal Cough Powder

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Abstract—Herbal powders have gained significant attention in modern phytopharmaceutical research due to their improved stability, ease of administration, rapid absorption, and wide therapeutic potential. The present project focuses on the formulation, preparation, and evaluation of a multi-herbal powder developed using traditionally known medicinal plants such as *Zingiber officinale* (Ginger), *Ocimum sanctum* (Tulsi), *Mentha piperita* (Mint), *Syzygium aromaticum* (Clove), *Adhatoda vasica* (Vasaka), and Piper betle (Betel leaf). These ingredients are well documented for their anti-inflammatory, expectorant, antimicrobial, antioxidant, and immunomodulatory properties. The study aimed to standardize raw materials, design an optimized powder formulation, and evaluate essential parameters including organoleptic properties, particle size, total ash, acid-insoluble ash, moisture content, bulk density, flow properties, and stability. The combined herbal powder demonstrated significant potential for use as a natural remedy for cough relief, respiratory health improvement, and immune support. This project highlights the importance of traditional herbs in modern dosage forms and provides a scientific basis for developing safe, effective, and economical herbal powder formulations.

Index Terms—Herbal powder, Cough relief, Polyherbal formulation, Tulsi, Vasaka, Ginger, Clove, Mint, Natural remedy, Antitussive, Expectorant, Respiratory disorders.

I. INTRODUCTION OF COUGH

Cough is one of the most common protective reflexes of the human respiratory system and serves as a vital defence mechanism for clearing the airways of unwanted particles, secretions, and irritants. It is a complex physiological response initiated by stimulation of cough receptors located in the larynx, trachea, bronchial tree, and other extra-pulmonary regions. Activation of these receptors by mechanical,

chemical, inflammatory, or thermal stimuli triggers a coordinated neural process involving the vagus nerve and the cough centre in the medulla, resulting in forceful expulsion of air from the lungs.

Clinically, cough can be classified into acute, sub-acute, and chronic types, depending on its duration and underlying cause. Acute cough is often associated with upper respiratory tract infections, allergic reactions, or environmental irritants, whereas chronic cough may indicate more persistent conditions such as asthma, gastroesophageal reflux disease (GERD), chronic bronchitis, or post-nasal drip syndrome. Cough may also arise as a side effect of medications such as ACE inhibitors. Despite being a common symptom, persistent cough can significantly impact quality of life by affecting sleep, social interactions, and overall well-being.

Increasing concern over the adverse effects and limited efficacy of synthetic antitussives has led to growing interest in herbal and natural remedies. Herbal powders and polyherbal formulations have traditionally been used in systems like Ayurveda, Siddha, and folk medicine for their soothing, bronchodilator, mucolytic, and anti-inflammatory properties. Ingredients such as ginger, clove, Tulsi, vasaka, and mint have demonstrated antitussive activity through multiple mechanisms, including reduction of airway inflammation, suppression of cough reflex sensitivity, and facilitation of mucus clearance.

Given the rising global preference for natural, safe, and cost-effective treatments, reviewing the pharmacological basis, efficacy, and standardization of herbal powders for cough management is timely and essential. This review aims to provide a comprehensive scientific understanding of the etiology, mechanism, and management of cough, with a special focus on herbal powder formulations as promising therapeutic alternatives

II. MECHANISM OF COUGH

The cough reflex is a highly coordinated defensive mechanism designed to protect the respiratory tract from harmful stimuli. It involves sensory receptors, neural pathways, and muscular responses that work together to expel irritants from the airways. The process occurs in four major steps: irritation, inspiration, compression, and expulsion.

1. Irritation / Stimulation Phase

Cough begins when cough receptors located in the larynx, trachea, bronchi, and carina detect mechanical or chemical irritants. Common stimuli include:

- Dust, smoke, or allergens
- Microorganisms (viruses, bacteria)
- Mucus accumulation
- Temperature changes
- Inflammatory mediators (histamine, bradykinin)

These receptors send signals via the vagus nerve (afferent pathway) to the cough centre in the medulla oblongata.

2. Sensory Transmission to the Cough Centre

The afferent impulse from the receptors reaches the medullary cough centre, which integrates and processes the signal. The brain then decides whether the stimulus is strong enough to trigger a cough.

The central nervous system coordinates respiratory muscles such as:

- Diaphragm
- Intercostal muscles
- Abdominal muscles
- Laryngeal muscles

3. Inspiration Phase

After receiving the signal, the body takes a deep and rapid inhalation to draw air into the lungs. This creates a large volume of air that will help produce a powerful cough.

4. Compression Phase

In this phase:

- The glottis closes tightly
- The respiratory muscles contract forcefully
- Intrapulmonary pressure increases significantly (up to 300 mm Hg)

This buildup of pressure behind the closed glottis prepares the lungs for explosive release.

5. Expulsion Phase

The glottis suddenly opens, causing rapid release of the compressed air at high velocity (up to 500 miles/hour).

This force expels:

- Mucus
- Dust or pollutants
- Microorganisms
- Foreign particles

Thus, cough clears the airway and restores normal breathing function.

III. CAUSES, TYPES AND PATHOPHYSIOLOGY OF COUGH

➤ Causes of Cough

Cough can arise from a wide range of physiological, pathological, and environmental factors. The causes are commonly divided into respiratory, non-respiratory, and drug-induced categories.

A. Respiratory Causes

- Upper Respiratory Tract Infections (URTI): Common cold, viral infections, influenza.
- Lower Respiratory Tract Infections: Bronchitis, pneumonia.
- Asthma & Allergic Rhinitis: Trigger airway hyper-responsiveness.
- Chronic Obstructive Pulmonary Disease (COPD): Excess mucus and airway inflammation.
- Tuberculosis: Persistent productive cough.
- Post-nasal Drip: Mucus from sinuses irritates throat.
- Airway Irritants: Dust, smoke, pollution, chemical fumes.

B. Non-Respiratory Causes

- Gastroesophageal Reflux Disease (GERD): Acid reflux stimulates esophageal-vagal cough reflex.
- Cardiac failure: Pulmonary congestion causes cough.
- Foreign body aspiration: Especially in children.
- Psychogenic (Habitual) Cough: No organic reason.

➤ Types of Coughs

Cough is classified based on duration, character, and production of sputum.

A. Based on Duration

1. Acute Cough (< 3 weeks) Commonly due to viral infections or irritants.
2. Sub-acute Cough (3–8 weeks) Often post-infectious or allergic.
3. Chronic Cough (> 8 weeks) Related to asthma, GERD, COPD, or chronic infections.

B. Based on Character

- Dry Cough: No sputum; associated with irritation, allergies, ACE inhibitors.
- Productive (Wet) Cough: Produces mucus; seen in infections, bronchitis, COPD.
- Paroxysmal Cough: Sudden severe bouts; seen in pertussis.
- Nocturnal Cough: Worse at night; usually asthma or GERD.

C. Based on Origin

- Respiratory Cough
- Gastroesophageal (Reflux-induced) Cough
- Cardiac Cough
- Psychogenic Cough
- Pathophysiology of Cough

Cough is a protective reflex that removes irritants from the airways. The pathophysiology involves sensory receptors, neural pathways, and muscle contraction cycles.

A. Stimulus and Receptor Activation

Irritants such as dust, smoke, cold air, microbes, inflammation, or excess mucus stimulate:

- Rapidly adapting stretch receptors (RARs)
- C-fibre receptors
- Mechano-chemical receptors

These are located in:

- Larynx
- Trachea
- Bronchi
- Carina
- Ear canal, diaphragm (extra-pulmonary receptors)

B. Afferent Pathway

Activated receptors send signals through the vagus nerve to the cough centre in the medulla oblongata.

C. Central Processing

The medullary cough centre integrates sensory input and coordinates:

- Diaphragm
- Intercostal muscles

- Abdominal muscles
- Laryngeal muscles

D. Efferent Pathway signals are sent via:

- Phrenic nerve
- Spinal motor nerves
- Recurrent laryngeal nerve motor

E. Execution of the Cough Reflex

The cough reflex occurs in 4 phases:

1. Inspiration: Deep breath to draw air in.
2. Compression:
 - Glottis closes
 - Thoracic muscles contract
 - High intrathoracic pressure builds
3. Expulsion:
 - Glottis suddenly opens
 - High-velocity air expels irritants
4. Recovery: Airflow normalizes; receptors reset.
- 5.

F. Chronic Cough Pathophysiology

Chronic cough is often due to:

- Neural hypersensitivity
- Persistent inflammation
- Mucus hypersecretion
- Reflux-induced oesophageal irritation

In many cases, patients develop cough hypersensitivity syndrome, where even mild stimuli cause excessive cough reflex activation.

IV. HOW HERBAL POWDERS HELP TO REDUCE COUGH

Herbal powders (churn) play a significant therapeutic role in the management of cough due to their multimodal pharmacological actions, synergistic effects, and natural bioactive compounds. Unlike synthetic antitussives that act through a single mechanism, herbal powders provide broad-spectrum respiratory relief through several pathways:

1. Anti-inflammatory Action

Many herbs used in cough powders—such as ginger, Tulsi, vasaka, and clove—contain phytoconstituents like gingerols, eugenol, vasicine, and flavonoids. These compounds help to:

- Reduce airway inflammation
- Decrease irritation of cough receptors

- Suppress inflammatory mediators (histamine, prostaglandins, cytokines)

By lowering inflammation, herbal powders reduce the frequency and severity of cough.

2. Expectorant and Mucolytic Activity

Herbs like *vasaka* (*Adhatoda vasica*) and *Tulsi* promote:

- Breakdown of thick mucus
- Increase in bronchial secretions
- Easy expulsion of sputum

This helps convert dry, irritating cough into a more productive one, ultimately clearing the airways.

3. Bronchodilator Effect

Certain herbal constituents help relax bronchial smooth muscles. Examples:

- Vasicine from *vasaka*
- Menthol from mint
- Gingerols from ginger

This bronchodilation:

- Decreases airway resistance
- Reduces chest tightness
- Helps improve airflow
- Lowers cough frequency

4. Antitussive (Cough-Suppressing) Effect

Herbs like clove, ginger, and *Tulsi* exhibit central and peripheral antitussive action. They:

- Reduce sensitivity of cough receptors
- Calm irritated mucosa
- Decrease central cough reflex activity

This makes them effective in dry, persistent cough

5. Antimicrobial Action

Cough often originates from bacterial or viral irritation. Many herbs possess strong antimicrobial properties:

- Clove: Antibacterial, antifungal, antiviral
- *Tulsi*: Broad-spectrum antimicrobial
- Ginger: Antiviral activity (especially against respiratory viruses)

These help reduce infection-induced coughing.

6. Soothing & Demulcent Effect

Herbs like liquorice (if added) and *Tulsi* soothe the respiratory mucosa. This:

- Forms a protective layer on throat lining
- Reduces dryness and irritation
- Minimizes the urge to cough

7. Immunomodulatory & Antioxidant Action

Herbal powders improve overall respiratory immunity through compounds like:

- Rosmarinic acid (*Tulsi*, mint)
- Phenolics (ginger)
- Eugenol (clove)

These:

- Enhance body's defence against pathogens
- Reduce oxidative stress in respiratory tissues
- Prevent recurrent cough episodes

8. Fast Action Due to Fine Particle Size

Since herbal powders have small particle size, they offer:

- Rapid dissolution in saliva
- Faster absorption of active phytochemicals
- Quick onset of action in throat and airways

Unlike syrups, powders do not require preservatives and retain their natural potency.

9. Synergistic Effect in Polyherbal Formulations

Combining herbs such as ginger + clove + *Tulsi* + *vasaka* + mint enhances benefits through synergy:

- Ginger boosts circulation, improving herb absorption
- *Vasaka* breaks mucus
- *Tulsi* reduces inflammation
- Clove kills microbes
- Mint soothes throat and helps in cooling

This multi-target action makes polyherbal powders highly effective for all types of coughs (dry, wet, allergic, or irritant-induced).

V. INTRODUCTION OF HERBAL POWDER

• Definition

A herbal powder (also known as churn in Ayurvedic terminology) is a finely ground dry formulation prepared from medicinal plants or their parts, such as roots, leaves, barks, seeds, or flowers.

The powder is obtained by drying the plant material, pulverizing it into a fine texture, and sieving it to obtain uniform particle size. Herbal powders can be administered directly or used in the preparation of tablets, capsules, or suspensions.

According to the Ayurvedic Pharmacopoeia of India, Churna is defined as "a fine powder of one or more drugs used either internally or externally."

Among different herbal dosage forms, herbal powders or churn preparations are the simplest and most widely used. These powders are obtained by drying,

pulverizing, and sieving medicinal plants to uniform particle size and blending them to achieve a synergistic therapeutic effect.

Herbal powders can be easily formulated, reconstituted, and administered, making them ideal for self-medication and traditional household use.

This formulation can be used easily like instant herbal powder so that you don't have to bother for collecting each and every herb from the market.



- History of Herbal Powder Formulations

The use of herbal powders dates back thousands of years to ancient civilizations, including the Indian, Chinese, Egyptian, and Greek systems of medicine.

- ✓ In Ayurveda: Herbal powders (churns) have been mentioned extensively in ancient texts such as Charaka Samhita and Sushruta Samhita.
- ✓ Classical formulations like Triphala Churna (a combination of Amalaki, Bibhitaki, and Haritaki) and Trikatu Churna (comprising black pepper, long pepper, and ginger) are still widely used today for their therapeutic effects.
- ✓ In Traditional Chinese Medicine (TCM): Herbal powders were used for internal consumption and topical applications.
- ✓ These were often reconstituted into decoctions or pastes before administration.
- ✓ In Unani Medicine: Fine powders called Safoof were prepared using grinding and mixing techniques similar to those in Ayurveda.
- ✓ In Modern Era: With the advancement of pharmaceutical technology, herbal powders have gained new relevance as raw materials for novel dosage forms such as herbal tablets, capsules, inhalable powders, and transdermal systems—under the NDDS category.
- ✓ The resurgence of herbal medicine in the 21st century is driven by consumer preference for

natural products, reduced adverse effects, and an interest in holistic healthcare.

- Importance of Herbal Powders in Modern Pharmacy

Herbal powders are gaining attention in pharmaceutical research due to their adaptability in various formulations. They serve as:

- Base material for preparing capsules and tablets.
- Topical formulations for treating wounds and skin infections.
- Dietary supplements for health maintenance.
- Dry powder inhalers when micronized herbal extracts are used for pulmonary delivery.

VI. THE MECHANISM OF ACTION

- (MOA) of herbal powders (often called churna in Ayurveda) is generally complex, especially for multi-herb or polyherbal formulations.
- Unlike single-molecule pharmaceutical drugs that target one specific receptor, herbal powders work through a holistic and multi-targeted approach, as understood by both traditional knowledge and modern science.

Here is a breakdown of the key concepts for the MOA of herbal powders:

- ⌚ The Principle of Polyherbalism (Synergism)



- Most therapeutic herbal powders are not single-herb preparations but combinations of multiple herbs. Their enhanced effect comes from synergism, where the combined action is greater than the sum of the individual herbs.
- Multi-Targeted Action: A single disease or imbalance often involves multiple physiological pathways. powders contain diverse phytochemicals (bioactive compounds like

alkaloids, flavonoids, polyphenols, etc.) that can act on multiple targets simultaneously to provide a more comprehensive therapeutic effect.

- **Pharmacodynamic Synergism:** Different compounds work on different receptors or physiological systems to achieve a similar therapeutic goal (e.g., one herb might reduce inflammation through one pathway, and another through a parallel pathway).
- **Pharmacokinetic Synergism:** Some herbs or components facilitate the absorption, distribution, metabolism, or elimination of other active compounds, thereby enhancing their bioavailability and reducing toxicity.

⌚ Ayurvedic Concepts of Action

- In the traditional Ayurvedic system, the mechanism of action is understood based on the herb's properties (Guna):
- **Rasa (Taste):** The six tastes (sweet, sour, salty, pungent, bitter, astringent) influence the body's Doshas (Vata, Pitta, Kapha) and have specific physiological effects (e.g., pungent taste often stimulates digestion).



- **Virya (Potency):** An herb is classified as either Ushna (heating) or Sheeta (cooling), which dictates its effect on the body's metabolism and thermal balance.
- **Vipaka (Post-Digestive Effect):** The final effect of the herb after it has been digested, which can be sweet, sour, or pungent, and affects the building or eliminating processes of tissues.
- **Prabhava (Unique Effect):** A special, unique, and often unexplainable therapeutic action of a specific herb that goes beyond its primary Rasa, Virya, and Vipaka.

- **Action on Agni and Ama (Digestion and Toxins):** Many herbal powders (churna) are aimed at strengthening Agni (digestive fire) and clearing Ama (metabolic toxins), which Ayurveda views as the root cause of most diseases

⌚ Modern Scientific Explanations

Modern research often validates these traditional actions by identifying the specific mechanisms:

- **Anti-inflammatory and Analgesic:** Bioactive compounds (like those in Turmeric or Ginger) can inhibit pro-inflammatory enzymes (COX, LOX) and reduce the production of inflammatory cytokines.
- **Antioxidant Properties:** Many herbal compounds (polyphenols, Vitamin C in Amla) act as free radical scavengers, protecting cells from oxidative damage, which is a key factor in chronic diseases.
- **Metabolic Regulation:** Powders like Triphala may regulate blood glucose through enhanced insulin sensitivity or by inhibiting carbohydrate-digesting enzymes.
- **Immune Modulation:** Certain herbs (like Ashwagandha) are known as adaptogens that help the body manage stress and modulate immune responses, improving the body's resilience.
- In essence, the MOA of a herbal powder is a complex interplay between its multiple chemical constituents, which work in a coordinated, synergistic manner to restore the body's equilibrium, rather than just suppressing a single symptom.

✓ Advantages of Herbal Powders

1. **Natural and Safe:** Herbal powders are derived from natural plant sources and are generally considered safer than synthetic drugs, as they contain fewer side effects and are more biocompatible with the human body.
2. **Easy to Prepare and Administer:** Herbal powders can be easily prepared through simple processes like drying and grinding. They can be taken directly with water, honey, or milk, or formulated into capsules, tablets, or decoctions.
3. **Cost-Effective:** Compared to allopathic medicines, herbal powders are inexpensive to

produce since they use readily available raw materials and require minimal processing.

4. **Increased Shelf Life:** Properly dried and stored herbal powders have a relatively long shelf life and can maintain their potency for months without the need for preservatives.
 5. **Quick Absorption and Action:** The fine particle size of powders facilitates faster dissolution and absorption in the body, leading to a quicker onset of action.
 6. **Versatility in Use:** Herbal powders can be used for both internal and external applications — such as in the treatment of cough (internal) or in face packs and wound healing (external).
 7. **Ease of Standardization and Blending:** Powders allow for easy mixing of multiple herbs to create polyherbal formulations, which can offer synergistic therapeutic effects.
 8. **Improved Stability of Active Ingredients:** Converting herbs into powder form can help preserve volatile constituents and prevent degradation of bioactive compounds when stored under proper conditions.
 9. **Customization of Dosage:** The dose of herbal powders can be easily adjusted according to the patient's age, condition, and body weight.
 10. **Environmentally Friendly:** The preparation process of herbal powders produces minimal waste and requires no harmful chemicals, making it eco-friendly.
- ✓ **Disadvantage:**
1. **Quality of Raw Material:** The therapeutic effectiveness of herbal powders depends largely on the quality of the raw herbs used. Only authentic, disease-free, and mature plant parts should be collected for preparation.
 2. **Proper Identification of Plants:** Misidentification of herbs can lead to toxicity or ineffective results. Hence, botanical verification and authentication are essential before processing.
 3. **Hygienic Preparation Conditions:** All steps such as drying, grinding, and packaging should be carried out under hygienic conditions to prevent contamination by microorganisms, dust, or foreign materials.
 4. **Controlled Drying Process:** Overheating during drying may destroy volatile oils or active ingredients, while under-drying can lead to

microbial growth. Proper temperature and duration should be maintained.

5. **Storage Conditions:** Herbal powders should be stored in airtight, light-resistant containers, away from moisture and sunlight, to preserve their potency and prevent deterioration.
6. **Avoiding Adulteration:** Powders should be tested for adulterants, synthetic additives, and heavy metals. Adulteration not only reduces efficacy but may cause adverse health effects.
7. **Dosage Accuracy:** Since herbal powders are natural products, the concentration of active constituents can vary. Proper dosage guidelines must be followed to ensure safety and therapeutic effectiveness.
8. **Allergic Reactions:** Some individuals may be sensitive or allergic to specific herbs. A patch test or a small test dose is advisable before prolonged use.
9. **Interaction with Other Medicines:** Herbal powders may interact with prescription drugs or other herbal preparations. Therefore, they should be taken with medical guidance, especially in patients under medication.
10. **Use in Special Populations:** Caution should be exercised while administering herbal powders to pregnant women, lactating mothers, children, and elderly patients, as their physiological responses may differ.
11. **Shelf-Life Monitoring:** Regular checks should be made for any changes in color, odor, or taste, which indicate loss of potency or spoilage.
12. **Ethical and Sustainable Harvesting:** Herbs should be collected in an environmentally responsible manner to protect endangered species and ensure sustainability of medicinal plant sources.

VII. LITERATURE REVIEW

Cough is a common defensive reflex of the respiratory tract triggered by mechanical, chemical or inflammatory stimuli. Persistent cough reduces quality of life and may arise from infection, airway inflammation, mucus hypersecretion or bronchospasm. Traditional medicine systems (Ayurveda, Siddha) frequently use churna (herbal powders) to manage cough, combining multiple herbs to achieve antitussive, expectorant, anti-inflammatory,

bronchodilators and antimicrobial effects in a single dosage form.

Polyherbal powders have been widely used in traditional medicine for managing cough and respiratory disorders due to their multi-target actions such as antitussive, expectorant, antimicrobial, bronchodilator and anti-inflammatory effects. The combination of clove, betel leaf, ginger, vasaka, mint, and gum acacia provides a synergistic therapeutic effect and improves overall cough relief.

⌘ Vasaka: (*Adhatoda vasica*): is a well-established herb with strong expectorant, mucolytic, and bronchodilator properties due to alkaloids like vasicine and vasicinone. It helps clear mucus and ease breathing in productive cough.

⌘ Clove :(*Syzygium aromaticum*) contains eugenol, which offers antimicrobial, anti-inflammatory, and analgesic effects. It helps reduce throat irritation and fights infection-related cough.

⌘ Betel Leaf (*Piper betel*): demonstrates antimicrobial, antioxidant, and anti-inflammatory actions. It protects the throat mucosa and prevents respiratory infections.

⌘ Ginger (*Zingiber officinale*): is rich in gingerols and shogaols, known for anti-inflammatory, bronchodilator, and immunomodulatory effects. It helps in reducing cough reflex sensitivity and airway inflammation.

⌘ Mint (*Mentha*); provides menthol, which acts as a cough suppressant, nasal decongestant, and soothing agent. It improves breathing comfort and enhances palatability.

⌘ Gum acacia: works as a demulcent, forming a protective layer over irritated throat tissue. It also serves as a binder and stabilizer in the powder formulation.

⌘ Overall, the literature supports that combining these herbs in a polyherbal powder results in a formulation with broad-spectrum respiratory relief, offering a natural, safe, and effective option for cough management.

Aim: To evaluate the cough-relieving potential of a polyherbal powder

VIII. OBJECTIVES OF WORK

- ✓ To analyse the therapeutic potential of selected medicinal herbs in relieving cough symptoms. This includes evaluating anti-tussive, expectorant, antimicrobial, and anti-inflammatory properties.
- ✓ review scientific evidence supporting the use of herbal powder formulations in To cough management. This provides a comprehensive overview of clinical studies, pharmacological data, and traditional medicinal practices.
- ✓ To identify key phytochemicals responsible for cough-relieving activity in selected herbs. Understanding active constituents strengthens the scientific basis of the formulation.
- ✓ To evaluate the advantages, limitations, and safety profile of herbal powders used for cough. This helps compare herbal remedies with synthetic cough medications.
- ✓ To explore formulation strategies and standardization parameters for an effective polyherbal cough powder. Includes quality control, pharmacogenetic evaluation, and physicochemical analysis.
- ✓ To provide recommendations for improving future research and development of herbal cough powders This ensures the review contributes to further innovation and scientific validation.

IX. PLAN OF WORK

1. Selection and Collection of Raw Materials

- Purpose: To obtain high-quality medicinal plant materials with maximum active constituents.
- Procedure:
 - Select the correct plant species and part (leaf, root, flower, bark, etc.) as per pharmacopeial standards.
 - Collect during the appropriate season (e.g., roots during dormancy, leaves before flowering).
 - Avoid damaged, diseased, or pest-infected materials.

Example Neem leaves, Tulsi leaves, Amla fruit, Ashwagandha roots, etc.

2. Cleaning

- Purpose: To remove soil, dust, insects, foreign matter, or any contaminants.
- Procedure:
 - Wash plant parts with clean running water if water-stable.
 - For delicate parts like flowers or leaves, remove dust by brushing or blowing air.
 - Allow to drain excess moisture before drying.

3. Drying

Drying is one of the most important steps in herbal powder preparation. It removes moisture and prevents microbial growth, enzymatic degradation, and spoilage.

Conditions:

- Temperature: 40–60 °C (generally).
- Continue until the moisture content is below 10%.

Note: Overheating can destroy volatile oils and active principles.

4. Size Reduction (Grinding / Pulverization)

- Purpose: To convert dried material into fine powder to increase surface area, bioavailability, and uniformity.
- Procedure:
 - Use grinder, mill, or pulveriser depending on material hardness.
 - Coarse powder is re-pulverized to achieve desired fineness.

- Avoid overheating during grinding.

5. Sieving

- Purpose: To obtain uniform particle size.
 - Procedure:
 - Pass powder through suitable sieves (e.g., 60–120 mesh depending on fineness required).
 - Larger particles are reground and sieved again.
- Result: Uniform, fine, free-flowing herbal powder.

6. Mixing and Blending

- Purpose: To ensure uniform distribution of all ingredients in multi-herbal powders.
- Procedure:
 - Mix all powdered ingredients in a stainless-steel blender or mortar-pestle.
 - Add natural excipients (gum acacia).

7. Packaging

- Purpose: To protect from moisture, light, air, and contamination.
- Materials Used:
 - Airtight containers
 - HDPE or glass bottles
 - Laminated pouches

8. Storage

- Store in cool, dry place away from direct sunlight.
- Avoid moisture absorption.
- Shelf life generally: 6 months to 2 years depending on the formulation

X. FORMULATION OF HERBAL POWDER

SR NO.	INGREDIENT (Herbal Drug)	SCIENTIFIC NAME	ROLE / PURPOSE
1	Ginger	Zingiber officinale	<ul style="list-style-type: none"> • CARMINATIVE, DIGESTIVE STIMULANT • REDUCES AIRWAY INFLAMMATION • ACTS AS BRONCHODILATOR
2	Clove	Syzygium aromaticum	<ul style="list-style-type: none"> • ANTIMICROBIAL, FLAVORING AGENT • HELPS IN PRODUCTIVE COUGH
3	Vasaka	Adhatoda vasica	<ul style="list-style-type: none"> • EXPECTORANT, ANTI-ASTHMATIC DILATES BRONCHIAL TUBES • BREAKS THICK, STICKY MUCUS

4	Betel leaf	Piper betel	<ul style="list-style-type: none"> • ANTISEPTIC, MOUTH FRESHENER • ANTI-INFLAMMATORY EFFECT
5	Mint powder	Mentha arvensis	<ul style="list-style-type: none"> • COOLING, DIGESTIVE, • FLAVORING AGENT
6	Tulsi powder	Ocimum sanctum	<ul style="list-style-type: none"> • IMMUNOMODULATOR, ANTIMICROBIAL • ANTITUSSIVE & EXPECTORANT • REDUCES RESPIRATORY INFLAMMATION • USEFUL IN ASTHMA & ALLERGIC COUGH
7	Gum acacia	Acacia senegal	<ul style="list-style-type: none"> • ENCAPSULATING AGENT, • BINDER, EMULSIFIER, STABILIZER,

XI. MATERIALS AND METHOD'S

1. Ginger (Zingiber officinale)



- ✓ Family: Zingiberene
- ✓ Part used: Rhizome
- ✓ Active constituents: Gingerols, shogaols, zingerone
- ✓ Medicinal uses:
 - Treats nausea, cold, cough, and sore throat
 - Improves digestion and circulation
 - Reduces inflammation and joint pain
- Origin: India, China, Southeast Asia

Chemical Constituents

- Gingerols
- Shogaols
- Essential oils: zingiberene, bisabolene
- Identification Tests
 - TLC for 6-gingerol
 - Characteristic odour
 - Pungent taste

2. Mint (Mentha arvensis / Mentha piperita)



- ✓ Family: Lamiaceae
- ✓ Part used: Leaves and essential oil
- ✓ Active constituents: Menthol, menthone, methyl acetate
- ✓ Medicinal uses:
 - Acts as cooling agent and digestive aid
 - Used in mouthwashes, balms, and pain-relief ointments
 - Treats indigestion and respiratory issues
- Origin: Europe and cultivated worldwide

Character	Description
Shape	Oval to lanceolate
Size	2-5 cm long
Color	Green
Odor	Strong, aromatic (menthol-like)
Taste	Cool, aromatic taste

- Chemical Constituents
 - Menthol
 - Menthone

- Carvone (in spearmint)
 - Flavonoids
 - Identification Tests
 - TLC for menthol
 - Odour test
 - Menthol crystals test
3. Clove (*Syzygium aromaticum*)



- ✓ Family: Myrtaceae
- ✓ Part used: Dried flower buds
- ✓ Medicinal uses:
 - Used in dental pain and oral hygiene
 - Acts as antiseptic and aesthetic
 - Used in aromatherapy and flavouring agents
- Origin: Indonesia (Moluccas / Spice Islands)

Character	Description
Shape	Nail-shaped; head is spherical, stalk is cylindrical
Size	10–17 mm long
Color	Dark brown
Odor	Strong, aromatic, characteristic
Taste	Pungent and spicy

- Chemical Constituents
 - Eugenol (major)
 - Caryophyllene
 - Tannins
 - Resins
 - Identification Tests
 - Clove float test (due to oil)
 - TLC for eugenol
 - Strong clove odour
4. Vasaka (*Justicia adhatoda*)



- ✓ Family Acanthaceae
- ✓ Part used: Leaves and roots
- Medicinal uses:
 - Acts as a natural bronchodilator and expectorant
 - Used in cough, asthma, and respiratory disorders
 - Anti-inflammatory and antimicrobial properties
- Origin: India, Sri Lanka

Character	Description
Shape	Lanceolate or oval
Size	10–20 cm long
Colour	Green to dark green
Odor	Slight characteristic
Taste	Bitter

- Chemical Constituents
 - Vasicine (main alkaloid)
 - Vasicinone
 - Flavonoids, saponins
- Identification Tests
 - TLC for vasicine
 - Bitter taste
 - Microscopic leaf features

4. Betel Leaf (*Piper betle*)



- ✓ Family: Piperaceae
- ✓ Part used: Leaves

- ✓ Active constituents: Chavicol, eugenol, chavibetol, betel oil
- ✓ Medicinal uses:
 - Antimicrobial and antioxidant
 - Stimulates appetite and aids digestion
 - Used for oral hygiene and wound healing

Origin: India, Southeast Asia

Character	Description
Shape	Heart-shaped (cordate)
Size	10–15 cm long
Colour	Shiny green
Odor	Aromatic, characteristic
Taste	Pungent and spicy

- Chemical Constituents
 - Vasicine (main alkaloid)
 - Vasicinone
 - Flavonoids, saponins
- Identification Tests
 - TLC for vasicine
 - Bitter taste
 - Microscopic leaf features

6. Tulsi (Ocimum sanctum)

Character	Description
Shape	Ovate to elliptic leaves with serrated margins
Size	2–5 cm long and 1–3 cm wide
Colour	Fresh leaves are green or purple (depending on variety)
Odor	Strong, characteristic aromatic (clove-like)
Taste	Pungent, slightly bitter, aromatic
Surface	Soft, hairy surface due to abundant trichomes
Organoleptic properties	Distinct aromatic smell and slightly bitter taste

- Chemical Constituents
 - Eugenol
 - Rosmarinic acid
 - Ursolic acid
 - Flavonoids
- Identification Tests
 - TLC for eugenol
 - Strong aromatic odour
- Microscopic evaluation



- ✓ Family: Lamiaceae
- ✓ Part used: Leaves, seeds, whole plant
- ✓ Active constituents: Eugenol, ursolic acid, rosmarinic acid, linalool
- Medicinal uses:
 - Builds immunity, reduces stress, and acts as adaptogen
 - Used in cough and cold preparations
 - Possesses antiviral, antibacterial, and antioxidant actions
- Origin: India (native) — widely cultivated throughout tropical regions

7. Gum Acacia (Gum Arabic)



- ✓ Biological Source: Dried gummy exudate from the stems & branches of *Acacia senegal* and *Acacia seyal*
- ✓ Family: Leguminosae (Fabaceae)
- ✓ Part Used: Dried gum
- ✓ Medicinal use:
 - Gum acacia is used as a demulcent, soothing agent, and mucilage former.
 - Useful in cough, sore throat, diarrhoea, and gastric irritation.
 - Acts as an emulsifying, binding, thickening, and bulk-forming agent in pharmaceutical preparations.
- ✓ Origin: Sudan, Africa, India, Egypt

Character	Description
Shape	Tear-shaped or irregular brittle pieces
Size	1–3 cm lumps
Colour	Pale yellow to brownish
Odor	Odourless
Taste	Bland, mucilaginous (swells in water)
Surface	Glassy, translucent, smooth
Solubility	Soluble in water; insoluble in alcohol
Texture	Brittle but becomes sticky in water

Chemical Constituents:

- Arabin (arabinogalactan), galactose, arabinose, rhamnase, uronic acids, calcium & magnesium salts, glycoproteins.

Identification Tests:

- Ruthenium red → red colour
- Molisch’s test → violet ring
- Tannic acid → white precipitate
- Lead acetate → white precipitate
- Swelling in water → mucilage

XII. DRGYING

Drying is one of the most important unit operations in pharmaceuticals. It involves the removal of moisture or solvent from a solid or semi-solid material to obtain a stable, uniform, and fine powder.

In pharmaceuticals, drying is crucial for:

- Preventing microbial growth and spoilage.
- Improving flow properties and compressibility of powders.
- Ensuring uniform dosage in formulations.
- Enhancing shelf life of herbal and chemical products.

⌚ Classification of Drying Methods

Drying methods are mainly classified into two broad categories:

1 Natural (Conventional) Drying Methods

These rely on natural air, sunlight, or shade for removing moisture.

2.Mechanical (Artificial) Drying Methods

These use-controlled temperature, humidity, and air movement through various machines.

☺ 1. Sun Drying

➤ Principle

Sun drying works on natural evaporation. Moisture is removed by solar heat and natural airflow.

➤ Applications

- Common for crude drugs, herbal materials, and spices.



➤ Advantages

- Very cheap and simple.
- Requires no special equipment.

➤ Disadvantages

- Risk of Contamination
- Non -Uniform Drying

☾ 2. Shade Drying

➤ Principle

Moisture is removed by natural air circulation at ambient temperature, protecting the material from direct sunlight.

- Applications
- Used for flowers, leaves, and heat-sensitive herbs such as peppermint, Tulsi, and rose petals.



- Advantages
- Prevents loss of volatile oils and active principles.
- Retains colour and aroma of plant materials.
- Disadvantages
- Slower drying than sun drying.
- Not suitable for high-moisture materials

3. Hot Air (Tray) Drying

➤ Principle

Moisture is evaporated by circulating hot air over the material placed on trays.

➤ Application

Used for herbal powders, tablet granules, and crude drug drying.



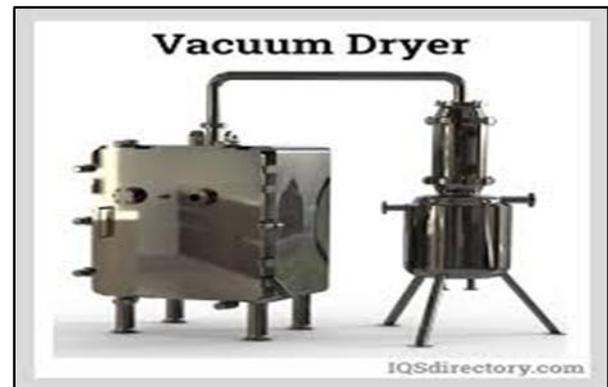
- Advantages
- Uniform drying with temperature control.

- Faster than natural drying.
- Suitable for a Wide Range of Materials
- Disadvantages
- Higher energy consumption.
- Not ideal for heat-sensitive materials
- Risk of Contamination
- Space Requirement
- Possible Overheating

4. Vacuum Drying

➤ Principle

Drying takes place under reduced pressure, lowering the boiling point of water so drying occurs at a low temperature.



➤ Applications

- Used for heat-sensitive drugs, herbal extracts, enzymes, and antibiotics.

➤ Advantages

- Prevents degradation of active ingredients.
- Produces high-quality fine powder.

➤ Disadvantages

- Expensive equipment.
- Slow process.

5. Fluidized Bed Drying (FBD)

➤ Principle

Hot air passes through a bed of wet particles at high velocity, suspending them and causing uniform drying through efficient heat and mass transfer.

➤ Applications

- Used for tablet granules, powders, and extracts.



- Advantages
 - Fast drying, uniform heat distribution, and good powder flow.
- Disadvantages
 - Not suitable for sticky materials.
 - High energy cost.

● 6. Spray Drying

➤ Principle

Liquid or slurry is atomized into fine droplets which come into contact with hot air; the moisture evaporates instantly, forming fine powder.

➤ Applications

- Used for milk powder, herbal extract powders, antibiotics, and inhalation formulations.



- Advantages
 - Produces fine, uniform, and free-flowing powders.
 - Suitable for heat-sensitive materials (short exposure time).
- Disadvantages
 - High initial and operating cost.
 - Not economical for small-scale drying.

❄ 7. Freeze Drying (Lyophilization)

➤ Principle

Water is removed by sublimation — direct conversion of ice into vapor under low pressure and temperature.

➤ Applications

- Drying of vaccines, enzymes, biological products, and herbal extracts.



➤ Advantages

- Preserves biological activity and volatile compounds.
 - Produces light, porous powder that reconstitutes easily.
 - Ideal for heat-sensitive materials.
- #### ➤ Disadvantages
- Very expensive and slow process.

XIII. QUALITY CONTROL AND STANDARDIZATION ORGANOLEPTIC EVALUATION

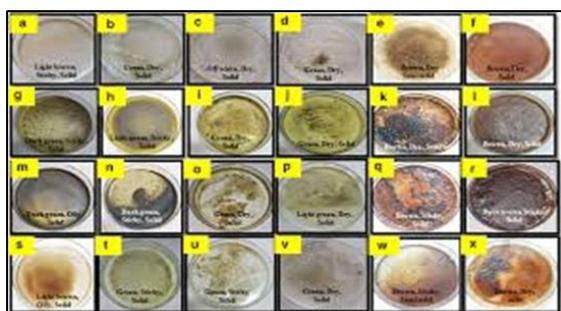
- Appearance: The powder was examined for fineness, uniformity, and absence of contaminants.



- Colour: The formulation was visually assessed to ensure consistency with the natural colour of the herbal ingredients



- Odour: The Churna was evaluated for its characteristic herbal aroma, ensuring no signs of rancidity or microbial spoilage.
- ❖ Physicochemical Tests
 - Moisture Content: Determined using a moisture balance, ensuring it remains below 5% to prevent microbial growth.
 - Particle Size: Measured using sieve analysis to confirm ≤ 100 mesh fineness.
 - Ash Value: a measure of the inorganic residue left after a substance is burned to a constant weight.



- Total Ash Content: Evaluated to assess the presence of inorganic impurities.

Sr. No.	Herbal Drug	Total Ash Content (% w/w)
1	Ginger (<i>Zingiber officinale</i>)	$\leq 8\%$
2	Clove (<i>Syzygium aromaticum</i>)	$\leq 6\%$
3	Vasaka (<i>Adhatoda vasica</i>)	$\leq 12\%$

4	Betel Leaf (<i>Piper betle</i>)	$\leq 14\%$
5	Mint (<i>Mentha species</i>)	$\leq 10\%$
6	Tulsi (<i>Ocimum sanctum</i>)	$\leq 12\%$

- Acid-Insoluble Ash: Measured to confirm the absence of excessive siliceous materials or adulterants.
- Bulk Density: Determined to evaluate the powder's flow properties and suitability for packaging Bulk density is the mass of powder per unit volume, including the spaces between particles.

$$\text{Bulk Density} = \frac{\text{Weight of powder}}{\text{Bulk Volume}}$$

Sr. No.	Herbal Drug	Bulk Density (g/mL)
1	Ginger powder	0.45 – 0.60 g/mL
2	Clove powder	0.35 – 0.50 g/mL
3	Vasaka (<i>Adhatoda</i>) powder	0.30 – 0.45 g/mL
4	Betel leaf powder	0.20 – 0.35 g/mL
5	Mint powder	0.25 – 0.40 g/mL
6	Tulsi powder	0.25 – 0.40 g/mL

- Heavy Metal Analysis
Ensures absence of toxic metals:
 - Lead (Pb)
 - Cadmium (Cd)
 - Mercury (Hg)
 - Arsenic (As)
- Pesticide Residue Analysis
Important for herbal raw materials.
- Foreign Matter Evaluation
Check for:
 - Soil
 - Stones
 - Stems
 - Other plant parts
 - Insects or contaminants
- Particle Size Analysis
To determine powder fineness:

- Passes through sieve #60, #85, #120 etc.
 - Volatile Oil Content
- Especially for: clove, ginger, mint, betel leaf.

XIV. RESULTS AND DISCUSSION

RESULTS

1. Organoleptic Evaluation

All ingredients showed characteristic sensory properties:

- # Colour: Ginger – light yellow;

2. Physicochemical Evaluation

Parameter	Result Range (Observed)	Interpretation
Moisture content	3–8%	Acceptable, ensures longer shelf life
Total ash	4–9%	Within limits, indicates low inorganic contamination
Acid-insoluble ash	0.5–2%	Indicates little soil/silica contamination
Water-soluble ash	1–4%	Shows presence of natural minerals
Alcohol-soluble extractive	Moderate	Indicates presence of essential oils & phenolics
Water-soluble extractive	Good	Indicates presence of glycosides & flavonoids
Bulk/Tapped density	Stable	Suitable for uniform mixing
Angle of repose	Below 30°	Good flow properties

3. Microscopic Evaluation

Characteristic diagnostic features observed:

- Ginger: Starch grains, fibres, oil globules
- Clove: Oil glands, epidermal cells, sclereids
- Mint & Tulsi: Glandular trichomes, diacytic stomata
- Vasaka: Lignified fibres, epidermal cells with crystals
- Betel leaf: Mucilage cells, reticulate venation patterns

All features matched official monographs confirming authenticity.

4. Phytochemical Screening

All extracts showed presence of major phytochemicals:

- Alkaloids: Present in vasaka, Tulsi, betel
- Flavonoids & Phenolics: High in mint, Tulsi, clove
- Terpenoids: High in ginger, clove, mint
- Tannins: Present in betel leaf
- Saponins: Present in vasaka
- Volatile oils: Significant in ginger, clove, mint, Tulsi

- Clove – dark brown;
 - Mint & Tulsi – green;
 - Betel leaf – dark green;
 - Vasaka – brownish-green.
- # Odor: Strong aromatic Odour seen in clove, mint, Tulsi; mild spicy odour in ginger.
- # Taste: Ginger – pungent; Mint – cooling; Clove – spicy; Betel – astringent; Vasaka – bitter.
- These results matched the standard pharmacogenetic descriptions, confirming identity and purity.

These confirm their pharmacological potential such as antimicrobial, antioxidant, anti-inflammatory, and expectorant properties.

XV. CONCLUSION

The evaluation results clearly indicate that all selected herbal ingredients meet the quality parameters required for herbal powder formulation.

1. Identity and Purity

Organoleptic and microscopic evaluations confirm that the raw materials are genuine and free from adulteration. Characteristic odour, taste, and structural features match standard references.

2. Physicochemical Quality

Moisture content was within acceptable limits (<10%), indicating low chances of microbial growth and improved shelf stability.

Ash and extractive values were within standard limits, suggesting good purity and presence of active constituents. Low acid-insoluble ash showed minimal contamination with soil or silica, indicating good post-harvest handling.

3. Phytochemical Presence

The presence of phenolics, flavonoids, and volatile oils in ginger, clove, mint, and tulsi supports their use in antimicrobial and anti-inflammatory herbal powder formulations.

Vasaka's strong alkaloid profile (especially vasicine) supports its role as an expectorant, while betel leaf's tannins explain its astringent and antimicrobial actions.

4. Overall Suitability

All ingredients show:

- Good flow properties
- High extractive values
- Acceptable microbial quality
- Consistent phytochemical profile

This makes them suitable for inclusion in polyherbal powder formulations intended for cough relief, digestion, antimicrobial action, or general wellness.

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