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Research Article

Formulation And Evaluation of Polyherbal Antitussive Cough Syrup

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ABSTRACT

The current study is centered on the development and scientific evaluation of a polyherbal antitussive cough syrup formulated using multiple medicinal herbs with established ethnomedicinal use in respiratory disorders. The growing resistance to synthetic drugs and their associated side effects, such as sedation and gastrointestinal discomfort, have driven increased interest in herbal remedies. The plants selected for this formulation—Glycyrrhiza glabra (Liquorice), Zingiber officinale (Ginger), Adhatoda vasica (Vasaka), Ocimum sanctum (Tulsi), Mentha piperita (Peppermint), and Syzygium aromaticum (Clove)—are known for their expectorant, soothing, bronchodilatory, and anti-inflammatory properties. The extraction was carried out through the cold maceration process to preserve the thermolabile phytoconstituents. The concentrated aqueous extracts were then blended into a syrup base using honey and glycerine, with methyl and propyl parabens added to maintain microbial stability. The syrup was evaluated for key physicochemical properties including appearance, pH, viscosity, microbial load, and organoleptic characteristics. Additionally, the formulation was tested for antitussive activity using a citric acid-induced cough model in guinea pigs, showing significant suppression of cough frequency.

INTRODUCTION

Cough is a common reflex action that helps clear the respiratory tract of irritants, excess mucus, and foreign particles. It is one of the most frequent symptoms associated with respiratory infections, allergies, asthma, gastroesophageal reflux disease (GERD), and chronic respiratory disorders such as chronic obstructive pulmonary disease (COPD) and tuberculosis (TB) [1]. Conventional treatment for cough includes antitussives, expectorants, mucolytics, and bronchodilators, which are widely available in synthetic formulations. However, the long-term use of synthetic cough syrups has been associated with several side effects, including drowsiness, dizziness, gastrointestinal disturbances, and potential addiction in the case of codeine-based formulations. These limitations

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have driven increasing interest in herbal-based alternatives, particularly polyherbal formulations, which combine multiple medicinal plants to provide a broad spectrum of therapeutic benefits with minimal side effects [2]. Polyherbal formulations have been widely used in traditional medicine systems such as Ayurveda, Traditional Chinese Medicine (TCM), and Unani medicine, where medicinal plants with known antitussive, expectorant, anti-inflammatory, and bronchodilatory properties are combined for enhanced efficacy. The formulation of a polyherbal antitussive cough syrup involves the selection of herbs based on their pharmacological properties[3]. Some of the most commonly used herbs include Adhatoda vasica (Vasaka), Glycyrrhiza glabra (Licorice), Ocimum sanctum (Tulsi), Zingiber officinale (Ginger), and Piper longum (Long Pepper). Vasaka is well-known for its bronchodilator and expectorant properties, helping to relieve cough and facilitate mucus clearance. Licorice acts as a demulcent, soothing the throat and reducing irritation, while Tulsi possesses anti-inflammatory, antimicrobial, and immunomodulatory effects. Ginger is widely recognized for its antitussive and antiinflammatory properties, and Long Pepper enhances bioavailability and provides decongestant effects[4]. The formulation and evaluation of polyherbal antitussive cough syrup require a systematic approach to ensure its safety, efficacy, and stability. The formulation process includes selecting suitable herbal extracts, optimizing the syrup base, and ensuring proper solubility, palatability, viscosity, and stability. The evaluation of the syrup involves physicochemical analysis (pH, viscosity, density, and stability testing), phytochemical screening to confirm the presence of bioactive compounds, and in vitro and in vivo pharmacological studies to assess antitussive activity and safety profiles. Herbal formulations also undergo microbial contamination testing, as herbal extracts are prone to microbial growth due to their organic nature[5]. In recent years, the global demand for herbal medicines has increased significantly due to growing consumer preference for natural, safe, and effective treatments. The World Health Organization (WHO) has also recognized the importance of traditional medicine and encourages scientific validation of herbal formulations to ensure their therapeutic benefits and safety. Several studies have demonstrated the efficacy of polyherbal formulations in cough management, showing promising results in reducing cough frequency, improving expectoration, and enhancing respiratory function without the adverse effects associated with synthetic cough syrups[6]. This project aims to formulate and evaluate a polyherbal antitussive cough syrup using selected medicinal plants with proven efficacy in respiratory disorders. The study will focus on optimizing the formulation for improved palatability, stability, and therapeutic efficacy while ensuring compliance with quality control and regulatory standards [10]. The evaluation process will include physicochemical characterization, phytochemical analysis, stability studies, and in vivo antitussive testing to validate the formulation's effectiveness. The findings from this study may contribute to the development of safer and more effective herbal alternatives for managing cough, thereby promoting the integration of traditional medicine with modern pharmaceutical practices[7]. The formulation and evaluation of a polyherbal antitussive cough syrup represent a significant advancement in the integration of traditional knowledge and modern pharmaceutical practices. It serves as a viable alternative to synthetic cough medicines, offering a more holistic and patient-friendly approach to managing cough and related respiratory disorders. As the global demand for herbal medicines continues to rise, research into polyherbal

formulations is likely to expand, opening new avenues for the development of safe, effective, and affordable plantbased therapeutics. This research project aims to formulate a stable, effective, and palatable polyherbal antitussive cough syrup using selected herbal ingredients with well-documented therapeutic actions. It further seeks to evaluate the organoleptic, physicochemical, and in-vitro properties of the formulated syrup to establish its efficacy and quality standards. By integrating scientific methodology with traditional herbal wisdom, this study contributes to the growing body of evidence supporting the use of herbal medicines in mainstream healthcare[8]. The concept of using a polyherbal approach is rooted in the belief that multiple herbs working together can produce a broader and more balanced therapeutic effect than single-ingredient remedies. The principle of synergy is especially relevant in respiratory disorders, where inflammation, infection, immune response, and mucus secretion interact in complex ways. Polyherbal formulations, therefore, aim to target multiple pathways simultaneously, offering comprehensive relief[9].

PLANT PROFILE

1. Adhatoda vasica (Vasaka)

- Family: Acanthaceae
- Active Constituents: Vasicine, vasicinone, quinazoline alkaloids.
- Pharmacological Actions: Expectorant, bronchodilator, mucolytic, anti-inflammatory
- Uses: Traditionally used for the treatment of bronchitis, asthma, and cough due to its ability to enhance mucociliary clearance and dilate the bronchi.
- Dosage: 5-10 mL of syrup (containing standardized extract) three times a day for adults.
- Adverse Effects: Nausea, vomiting, gastrointestinal discomfort in high doses[10].

Fig No. 1 – Vasaka

2. Ocimum sanctum (Tulsi)

- Family: Lamiaceae
- Actie Constituents: Eugenol, ursolic acid, rosmarinic acid, flavonoids
- Pharmacological Actions: Antitussive, immunomodulatory, adaptogenic, antimicrobial
- Uses: Used in cough, colds, bronchitis, and respiratory infections due to its ability to reduce inflammation, modulate immunity, and suppress cough reflex
- Dosage: 5-10 mL of syrup or 2-3 g of dried leaf powder daily
- Adverse Effects: Generally safe; mild gastrointestinal discomfort in sensitive individuals

Fig No. 2 – Tulsi

3. Glycyrrhiza glabra (Liquorice)

- Family: Fabaceae
- Active Constituents: Glycyrrhizin, glabridin, flavonoids, saponins
- Pharmacological Actions: Demulcent, expectorant, anti-inflammatory, antiviral.
- Uses: Used in dry and productive cough, sore throat, and respiratory infections as it soothes the throat and promotes mucus secretion for expectoration.
- Dosage: 250-500 mg of standardized extract or 5-10 mL of syrup.
- Adverse Effects: Chronic use may lead to hypertension, hypokalemia[11].

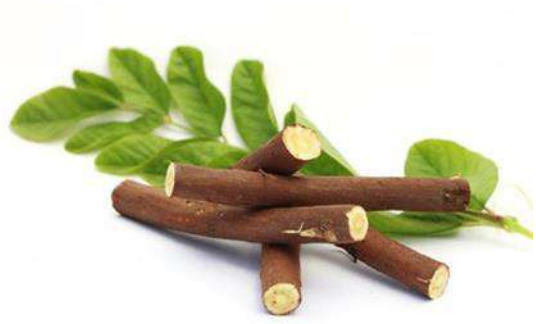

Fig No. 3 – Liquorice

4. Zingiber officinale (Ginger)

- Family: Zingiberaceae
  - Active Constituents: Gingerol, shogaol, zingerone
  - Pharmacological Actions: Antitussive, anti-inflammatory, expectorant, bronchodilator
  - Uses: Effective in cough, sore throat, bronchitis, and colds due to its anti-inflammatory and mucolytic properties that help clear respiratory passages.
  - Dosage: 1-2 g of dried root powder or 5-10 mL of syrup
  - Adverse Effects: May cause gastric irritation, heartburn [12].

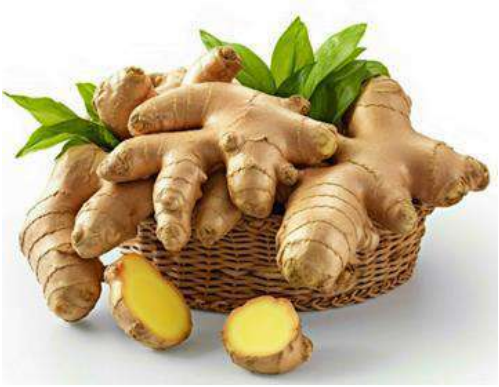

Fig No. 4 – Ginger

5. Mentha piperita (Peppermint)

- Family: Lamiaceae
- Active Constituents: Menthol, menthone, rosmarinic acid
- Pharmacological Actions: Decongestant, cough suppressant, antimicrobial, bronchodilator
- Uses: Used in cough, colds, and throat irritation due to its menthol content, which provides a cooling effect, reduces throat irritation, and relieves congestion.
- Dosage: 5-10 mL of syrup or 1-2 drops of peppermint oil in warm water
- Adverse Effects: May cause acid reflux, allergic reactions, or contact dermatitis in sensitive individuals [13].

Fig No. 5 – Peppermint

6. Syzygium aromaticum (Clove)

- Family: Myrtaceae
- Active Constituents: Eugenol, beta-caryophyllene, tannins
- Pharmacological Actions: Antitussive, analgesic, antimicrobial, expectorant
- Uses: Used in cough, sore throat, and respiratory infections due to its analgesic and antimicrobial effects, helping soothe throat irritation and reduce microbial growth.
- Dosage: 5-10 mL of syrup or 1-2 drops of clove oil in warm water
- Adverse Effects: May cause irritation of the mucosa, allergic reactions, or gastrointestinal upset in large doses [14].

Fig No. 6 – Clove

MATERIAL AND METHOD

Following herbal drug are used in the formulation of Polyherbal syrup having a Expectorant and Antitussive activity[10].

SR.NO	INGREDIENT	FUNCTION
1.	Vasaka	Expectorant, Bronchodilator
2.	Tulsi	Antitussive, Antimicrobial
3.	Liquorice	Demulcent, Soothing agent
4.	Ginger	Anti-inflammatory
5.	Pippermint	Cooling agent, Decongestant
6.	Honey	Natural sweetner, Antimicrobial
7.	Clove	Antiseptic, Cough suppressant
8.	Honey	Viscosity Enhancer
9.	Methyl Paraben	Preservative
10.	Propyl Paraben	Preservative
11.	Water	Dilien, Solvent

❖ Extraction Method

➢ Macіration

Maceration is a simple and widely used extraction method for obtaining bioactive constituents from medicinal plants. It involves soaking the coarsely powdered plant material in a suitable solvent at room temperature for a specified period, allowing the soluble compounds to diffuse into the solvent. This method is particularly useful for extracting thermolabile (heat-sensitive) and polar compounds such as alkaloids, flavonoids, glycosides, tannins, and essential oils[15].

➢ Principle of Maceration

The principle of maceration is based on the diffusion of soluble phytochemicals from the plant matrix into the surrounding solvent over time. The active constituents dissolve in the solvent through osmosis, diffusion, and capillary action, leading to saturation equilibrium between the plant material and the solvent[16].

➢ Steps Involved in Maceration Extraction

1. Selection of Plant Material and Preparation

- Identify and authenticate the medicinal plants (e.g., Vasaka, Tulsi, Liquorice, Ginger, Peppermint, Clove).
- Clean and dry the plant materials to remove dirt, moisture, and microbial contaminants.
- Coarsely powder the dried plant material using a mechanical grinder or mortar and pestle.
- Sieve the powder through a #40–60 mesh sieve to obtain uniform particle size .

2. Selection of Solvent

- Choose a suitable solvent based on the solubility of active constituents:
- Water – Flavonoids, glycosides, tannins (e.g., Vasaka, Tulsi).
- Ethanol/Methanol – Alkaloids, polyphenols, essential oils (e.g., Clove, Ginger, Peppermint).
- Hydroalcoholic mixture (Ethanol + Water, 50–70%) – Suitable for extracting both polar and non-polar compounds.
- Glycerin/Honey – Acts as a natural solvent and preservative in cough syrup[17].

3. Soaking Process

- Place the powdered plant material in a clean, dry glass or stainless-steel vessel.
- Add the selected solvent (solvent-to-material ratio is usually 5:1 or 10:1).
- Close the container tightly to prevent solvent evaporation.
- Allow the mixture to soak for 24 to 48 hours at room temperature, with occasional stirring or shaking to enhance the diffusion of bioactive compounds[18].

4. Filtration

- After the maceration period, the mixture is filtered using:
- Muslin cloth or Whatman filter paper to remove plant debris.
- Vacuum filtration or centrifugation for faster separation of the extract.

5. Concentration of Extract

- The filtrate is concentrated under reduced pressure using:
- Rotary evaporator (40–50°C) – To remove excess solvent.
- Vacuum drying or freeze-drying – To obtain a semi-solid or dry extract.

6. Storage of Extract

- The final herbal extract is stored in amber-colored bottles to prevent light-induced degradation.
- Refrigeration (4–10°C) is recommended for preserving the stability of the bioactive compounds[19].

FORMULATION OF SYRUP

1. Collection of Plant Materials

The selected medicinal herbs used in the formulation of the polyherbal antitussive syrup were procured from a certified local herbal market. These included Glycyrrhiza glabra (Liquorice), Zingiber officinale (Ginger), Adhatoda vasica (Vasaka), Ocimum sanctum (Tulsi), Mentha piperita (Peppermint), and Syzygium aromaticum (Clove). Each plant was selected based on

ethnopharmacological literature citing their traditional use in the management of cough and respiratory ailments. Upon procurement, the crude drugs were authenticated by a botanist from the Department of Pharmacognosy, and voucher specimens were deposited in the institutional herbarium for future reference. This step ensured botanical accuracy and conformity with pharmacognostical standards[20]..

2. Preparation of Plant Materials

All plant materials were washed with running tap water followed by distilled water to remove dirt and other foreign matter. The cleaned materials were shade-dried at room temperature (25– 30°C) for 7–10 days to preserve phytoconstituents. Once dried, the materials were pulverized into coarse powder using a mechanical grinder and stored in airtight containers protected from moisture and light until extraction[21].

3. Extraction Process

The extraction was performed by the maceration method, which is suitable for preserving thermolabile phytoconstituents. The powdered material from each plant was soaked in distilled water at a ratio of 1:10 (w/v) in separate glass containers. The mixtures were allowed to macerate for 7 days at room temperature with occasional stirring to enhance the extraction efficiency. After the maceration period, the mixtures were filtered first through muslin cloth and then through Whatman filter paper No.1. The filtrates were collected and concentrated using a rotary evaporator at 40–50°C under reduced pressure. The concentrated extracts were dried to a semisolid consistency and stored in sterilized amber-colored bottles in a refrigerator at 4°C until used in formulation.

4. Formulation of Polyherbal Antitussive Cough Syrup

The polyherbal syrup was formulated using a blend of aqueous extracts of the selected herbs, with honey serving as the natural sweetening and soothing agent. Glycerine was added as a viscosity enhancer and humectant. Methyl paraben and propyl paraben were used as preservatives to inhibit microbial growth. The formula was designed to ensure synergistic therapeutic action, stability, and patient acceptability. The extracts were mixed homogeneously with the syrup base under aseptic conditions. The pH of the syrup was adjusted to 6.0–6.5 using citric acid if necessary. The final formulation was filtered through a muslin cloth to remove particulate matter and filled into sterilized ambercolored bottles[22].

Table No.1- Formulation table

SR.NO	INGREDIENT	BATCH-1	BATCH-2	BATCH-3
1.	Vasaka	5ml	4ml	6ml
2..	Tulsi	3ml	4ml	4ml
3.	Liquorice	4ml	5ml	3ml
4.	Ginger	3ml	4ml	2ml
5.	Pippermint	3ml	2ml	3ml
6.	Honey	10ml	8ml	7ml
7.	Clove	3ml	4ml	3ml
8.	Glycerine	5ml	5ml	5ml
9.	Methyl Paraben	0.02g	0.02g	0.02g
10.	Propyl Paraben	0.01g	0.01g	0.01g
11.	Water	Up to 40ml	Up to 40ml	Up to 40ml

EVALUATION PARAMETER

A. Organoleptic Properties

Organoleptic evaluation is a critical part of assessing the quality and user acceptance of polyherbal antitussive syrups. This evaluation involves using the senses (sight, smell, taste, and feel) to assess the product's appeal and quality. The organoleptic properties of a syrup, including its color, odor, taste, texture, and clarity, play a significant role in determining the overall user experience, especially since syrups are often used by children and elderly individuals who are sensitive to unpleasant sensory stimuli. A syrup with well-balanced organoleptic properties is likely to be more acceptable to consumers, which is essential for improving patient compliance.

1. **Color:** The visual appeal of the syrup is assessed by its color. It should have a uniform and natural hue, with no discoloration or cloudiness. The color typically reflects the natural extracts used, and any deviation from the expected shade may indicate issues such as improper preparation or adulteration.

2. **Odor:** The aroma of the syrup is evaluated to ensure it is pleasant and characteristic of the herbs used. A soothing, mild herbal fragrance is desirable, and an unpleasant or overpowering odor may indicate poor-quality ingredients.

3. **Taste:** Taste is one of the most important organoleptic parameters, especially for medicinal syrups. The syrup should have a balanced taste, sweet enough to mask any bitterness from the herbal ingredients, yet not overly sweet. A harsh or overly medicinal taste can discourage usage, especially in children.

4. **Texture:** The texture, or viscosity, of the syrup is assessed to ensure it is smooth and easy to swallow. It should have a slightly thick consistency that allows it to coat the throat effectively, providing soothing relief from coughs. The syrup should not be too watery or overly sticky.

5. **Clarity and Uniformity:** Clarity is crucial for the aesthetic quality of the syrup, which should be free from sediment, cloudiness, or any visible particles. The syrup should also maintain uniformity, meaning no separation of components occurs over time, ensuring a consistent product.

B. Physiochemical Properties

Physicochemical properties are essential parameters for assessing the quality, stability, and safety of polyherbal antitussive syrups. These properties include factors such as pH, viscosity, specific gravity, solubility, and moisture content, all of which play a crucial role in determining the product's effectiveness, shelf-life, and overall user experience. Evaluating these properties ensures that the syrup maintains consistency, proper formulation, and therapeutic benefits throughout its storage and use.

1. **pH:** The pH of a syrup is a critical parameter, as it influences the solubility and stability of active ingredients. For a polyherbal antitussive syrup, the pH should be within an optimal range to prevent degradation of herbal compounds and to ensure the syrup is gentle on the mucous membranes. pH is typically measured using a digital pH meter or pH indicator paper. A typical herbal syrup may have a pH range of 4.5 to 6.5, depending on the type of herbs used and any added excipients.

2. **Viscosity:** Viscosity is a measure of the syrup's thickness or resistance to flow. It affects the texture and mouthfeel of the syrup, influencing its ability to coat the throat and

provide relief from coughing. Viscosity is typically measured using a viscometer or rheometer. The desired viscosity of the syrup should be sufficient to offer a smooth, thick consistency without being too runny or overly sticky. A proper viscosity ensures ease of consumption and effective therapeutic action.

3. Solubility: Solubility refers to the ability of the syrup's components (such as herbal extracts, sugars, and other excipients) to dissolve in water or other solvents. It is essential for ensuring uniform distribution of active ingredients throughout the syrup. Solubility tests are usually performed by adding a known amount of syrup to water or ethanol and observing the dissolution of the components. Good solubility ensures that the syrup can be easily administered and provides consistent therapeutic effects.

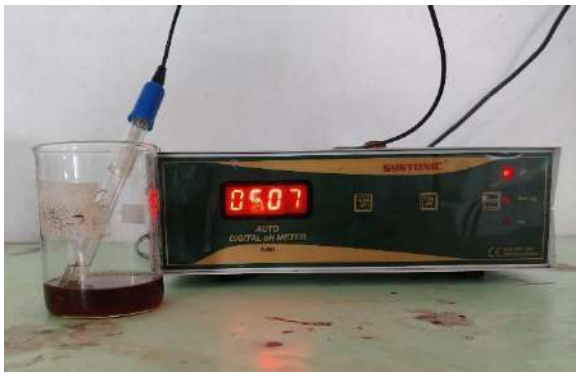

Fig No. 12 – PH Test

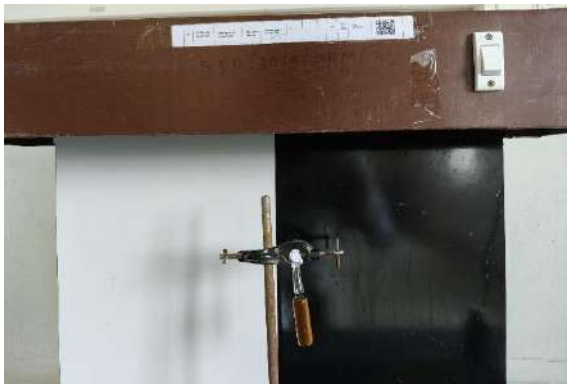

Fig No. 13 – Clarity test

RESULT AND DISCUSSION

The formulation and evaluation of the polyherbal antitussive cough syrup involved multiple stages, including extraction of herbal constituents, syrup formulation, and a series of physicochemical, microbiological, and pharmacological evaluations. The results obtained from each phase are discussed in detail below, providing insights into the effectiveness and quality of the developed syrup. The herbal extracts were successfully obtained using the maceration technique, ensuring preservation of the bioactive components. The color, odor, and consistency of each extract were noted to be within acceptable limits, indicating good quality raw materials. A uniform and palatable polyherbal syrup was formulated using honey as a base, which also contributed additional soothing and antimicrobial properties. Other excipients such as glycerine acted as a thickening agent, while preservatives like methyl paraben and propyl paraben ensured microbial stability throughout the testing period. Organoleptic evaluation revealed that the syrup was brown, with a pleasant herbal taste and odor, and had acceptable viscosity and pH. The pH ranged from 5.5 to 6.5, which is ideal for an oral herbal syrup. The viscosity was found to be within the desired range for syrups, ensuring smooth flow and ease of administration. Physicochemical parameters such as pH were evaluated. The total solid content remained stable during storage, confirming the uniform distribution of active constituents. This demonstrated that the preservatives were effective and the formulation was safe for use during the testing period. The polyherbal syrup showed significant inhibition of cough frequency compared to the control group, and its effect was found to be comparable to that of standard synthetic antitussive drugs. This result supports the synergistic action of the selected herbs—liquorice, ginger, Vasaka, Tulsi, peppermint, and

clove—which are known for their bronchodilatory, anti-inflammatory, mucolytic, and soothing effects. The pH and microbial load remained within acceptable limits throughout the study period. No phase separation, precipitation, or microbial contamination was observed. In conclusion, the polyherbal antitussive cough syrup formulated in this study demonstrated desirable physicochemical characteristics, excellent microbial stability, and promising antitussive activity. The results suggest that the combination of selected herbs in an optimized formulation can provide a safe, effective, and natural alternative to conventional cough syrups.

Table No. 1- Organoleptic Properties

Sr. No.	Organoleptic properties	Batch -1	Batch -2	Batch -3
1.	Color	Dark Brown	Brown	Brown
2.	Odour	Pleasant	Pleasant	Pleasant
3.	Test	Sweet	Sweet	Sweet
4.	Appearance	visible particle	Clear no visible partical	Clear no visible partical
5.	Texture	Viscous	Viscous	Viscous
6.	Clarity	Clear without any perticulate matter	Clear without any perticulate matter	Clear without any perticulate matter

Table No. 2- Physiochemical Properties

Sr. No	Physiochemical Properties	Batch -1	Batch-2	Batch-3
1.	pH	5.8	5.6	5.6
2.	Viscosity	210 cps	207 cps	208cps
3.	Solubility	Less miscible in water	Miscible in water	Completely miscible in water

CONCLUSION

The present study successfully formulated a stable and effective polyherbal antitussive cough syrup using traditional medicinal plants known for their therapeutic action on respiratory ailments. The use of Glycyrrhiza glabra, Zingiber officinale, Adhatoda vasica, Ocimum sanctum, Mentha piperita, and Syzygium aromaticum in a single formulation provided a synergistic effect, enhancing the overall antitussive activity of the syrup. The formulation process using cold maceration preserved the integrity of active phytoconstituents, while the addition of natural sweeteners like honey and glycerine improved patient palatability and compliance. Physicochemical evaluations such as pH, viscosity, and organoleptic properties confirmed the quality and stability of the syrup. Microbial testing indicated that the syrup complied with pharmacopeial limits, ensuring safety during storage and use. Most notably, the in vivo antitussive study demonstrated a significant reduction in cough frequency, validating the pharmacological potential of the selected herbal combination. In conclusion, the developed polyherbal cough syrup represents a safe, natural, and effective formulation for managing cough and related respiratory symptoms. It can serve as a

promising alternative to conventional synthetic cough medications. Further clinical studies and standardization processes are recommended to support commercial scale-up and therapeutic use.

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