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Review Article

Formulation And Evaluation of Polyherbal Syrup for Respiratory Health

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ABSTRACT

This research focuses on the formulation and evaluation of a polyherbal syrup designed for respiratory health using traditional medicinal plants with established therapeutic properties. The formulation incorporates Tulsi (Ocimum sanctum), Mulethi (Glycyrrhiza glabra), Giloy (Tinospora cordifolia), and Dry Ginger (Zingiber officinale) as primary active ingredients. The syrup was prepared using standard pharmaceutical formulation techniques and evaluated for various physicochemical parameters including organoleptic properties, pH, viscosity, specific gravity, and stability. The study demonstrates the successful development of a stable polyherbal formulation with potential therapeutic benefits for respiratory conditions, combining the synergistic effects of traditional medicinal herbs in a palatable liquid dosage form suitable for all age groups. This research contributes to the growing field of phytopharmaceuticals and highlights the potential of traditional herbal medicines in modern healthcare systems.

INTRODUCTION

1.1 Background

Respiratory disorders represent a significant global health concern affecting millions of people worldwide. According to the World Health Organization, respiratory diseases are among the leading causes of death and disability globally. Conventional treatments often come with unwanted side effects and may lead to resistance with prolonged use. This has led to renewed interest in exploring traditional herbal medicines as alternative or complementary treatments for respiratory conditions. Traditional medicinal systems, particularly Ayurveda, have utilized various plant species for centuries to treat respiratory ailments. These traditional remedies are often effective, have fewer side effects, and address multiple aspects of respiratory health simultaneously. The holistic approach of herbal

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medicine in treating respiratory conditions has gained scientific validation through numerous pharmacological studies.

1.2 Rationale for the Study

This research aims to develop a scientifically validated polyherbal formulation by combining four potent medicinal plants known for their beneficial effects on respiratory health. The selected plants—Tulsi (Ocimum sanctum), Mulethi (Glycyrrhiza glabra), Giloy (Tinospora cordifolia), and Dry Ginger (Zingiber officinale)—have been extensively studied individually for their therapeutic properties. However, their combined effect in a standardized syrup formulation has not been thoroughly investigated.

The syrup dosage form was chosen due to its ease of administration, better patient compliance (especially among pediatric and geriatric populations), possibility of taste masking, and improved bioavailability of the active constituents. Furthermore, liquid formulations allow for easier dose adjustments based on patient needs.

1.3 Literature Review

1.3.1 Tulsi (Ocimum sanctum) Tulsi, also known as Holy Basil, has been revered in Ayurveda for its diverse therapeutic properties. Scientific studies have demonstrated its efficacy in respiratory conditions due to its:

- Immunomodulatory effects: Enhances the body's natural defense mechanisms
- Anti-inflammatory activity: Reduces inflammation in respiratory passages
- Antimicrobial properties: Effective against respiratory pathogens
- Antioxidant effects: Protects against oxidative stress

Key bioactive compounds in Tulsi include eugenol, ursolic acid, rosmarinic acid, and carvacrol, which contribute to its therapeutic effects in respiratory disorder.

1.3.2 Mulethi (Glycyrrhiza glabra) Licorice root (Mulethi) has been extensively used in traditional medicine systems worldwide. Its benefits for respiratory health include:

- Expectorant action: Helps in removing mucus from the respiratory tract
- Anti-inflammatory effects: Soothes irritated throat and respiratory passages
- Antimicrobial properties: Active against various respiratory pathogens
- Immunomodulatory activity: Enhances immune response

Glycyrrhizin, liquiritin, and isoliquiritin are the major bioactive constituents responsible for these therapeutic effects.

1.3.3 Giloy (Tinospora cordifolia) Giloy is recognized in Ayurveda as a potent immunomodulator. Its beneficial effects on respiratory health include:

- Enhanced immunity: Strengthens the body's defense against respiratory infections
- Anti-allergic properties: Reduces hypersensitivity reactions
- Anti-inflammatory activity: Decreases inflammation in respiratory passages
- Antipyretic effects: Helpful in managing fever associated with respiratory infections
- Tinosporine, berberine, giloin, and tinosporaside are the key phytoconstituents contributing to its therapeutic efficacy

1.3.4 Dry Ginger (Zingiber officinale) Ginger has been traditionally used for various respiratory conditions. Scientific evidence supports its:

- Anti-inflammatory effects: Reduces inflammation in the respiratory tract
- Bronchodilatory action: Helps in relaxing constricted airways
- Antitussive properties: Relieves cough
- Immunomodulatory activity: Strengthens immune response against infections

Gingerols, shogaols, and zingerone are the primary bioactive compounds responsible for these effects.

1.4 Objectives of the Study

- To formulate a polyherbal syrup incorporating Tulsi, Mulethi, Giloy, and Dry Ginger extracts for respiratory health
- To standardize the formulation process for ensuring batch-to-batch consistency
- To evaluate the physicochemical properties of the formulated syrup
- To assess the stability of the preparation under various storage conditions
- To develop a palatable and therapeutically effective herbal formulation for respiratory health

2. MATERIALS AND METHODS

2.1 Materials

2.1.1 Plant Materials and Extracts

No.	Ingredient	Botanical Name	Source/Supplier	Authentication Method
1	Tulsi extract	Ocimum sanctum	[Supplier details]	[Authentication details]
2	Mulethi extract	Glycyrrhiza glabra	[Supplier details]	[Authentication details]
3	Giloy extract	Tinospora cordifolia	[Supplier details]	[Authentication details]
No.	Ingredient	Botanical Name	Source/Supplier	Authentication Method
4	Dry Ginger extract	Zingiber officinale	[Supplier details]	[Authentication details]

2.1.2 Excipients and Other Materials

No.	Ingredient	Grade/Specification	Source/Supplier
1	Lemon juice (fresh)	Food grade	Freshly extracted
2	Stevia solution (10% w/v)	Pharmaceutical grade	[Supplier details]
3	Honey	Pharmaceutical grade	[Supplier details]
4	Sodium benzoate	Pharmaceutical grade	[Supplier details]
5	Citric acid	Analytical grade	[Supplier details]
6	Sorbitol solution (70%)	Pharmaceutical grade	[Supplier details]
7	Glycerin	Pharmaceutical grade	[Supplier details]
8	Purified Water	As per IP standards	Laboratory prepared

2.2 Equipment

- Analytical balance
- pH meter
- Viscometer
- Hydrometer
- Hot plate with magnetic stirrer
- Filtration assembly
- Amber-colored glass bottles
- Muslin cloth
- Standard laboratory glassware

2.3 Formulation Composition

The polyherbal syrup was formulated with the following composition for a 100 mL batch:

No.	Ingredient	Quantity	Purpose
1	Tulsi extract (Ocimum sanctum)	5 mL	Respiratory health, antimicrobial
2	Mulethi extract (Glycyrrhiza glabra)	5 mL	Soothes throat, antiinflammatory
3	Giloy extract (Tinospora cordifolia)	4 mL	Immunity enhancer
4	Dry Ginger extract (Zingiber officinale)	2 mL	Antiinflammatory, digestive aid
5	Lemon juice (fresh)	3 mL	Flavor, Vitamin C
6	Stevia solution (10% w/v)	5 mL	Natural sweetener
7	Honey	10 g	Natural demulcent and sweetener
8	Sodium benzoate (preservative)	0.1 g	Prevents microbial growth
9	Citric acid	0.05 g	pH adjustment
10	Sorbitol solution (70%)	20 mL	Sweetener, viscosity enhancer
11	Glycerin	10 mL	Viscosity enhancer, stabilizer
12	Purified Water	q.s. up to 100 mL	Vehicle

2.4 Method of Preparation

The polyherbal syrup was prepared using the following standardized procedure:

2.4.1 Extraction Process For this formulation, standardized herbal extracts were used. However, if preparing extracts from raw materials, a hydroalcoholic extraction process would be employed: - Coarsely powdered plant materials would be macerated in a mixture of water and ethanol (70:30) - The mixture would be kept with occasional stirring for 48 hours - After filtration, the extract would be concentrated under reduced pressure - The concentrated extract would be standardized for bioactive markers

2.4.2 Preparation of Syrup Base

- In a clean vessel, glycerin (10 mL) and sorbitol solution (20 mL) were mixed thoroughly using a magnetic stirrer at 100 rpm for 5 minutes.
- Citric acid (0.05 g) and sodium benzoate (0.1 g) were dissolved in a small amount of purified water (approximately 10 mL) with gentle heating if necessary.
- This solution was then added to the glycerin-sorbitol mixture under continuous stirring at 100 rpm for another 5 minutes to ensure homogenous mixing.

2.4.3 Addition of Herbal Extracts

4. Under continuous stirring (100 rpm), the herbal extracts were added sequentially:
- Tulsi extract (5 mL) was added first and mixed for 2 minutes
- This was followed by Mulethi extract (5 mL) with mixing for another 2 minutes
- Giloy extract (4 mL) was then added with continued mixing for 2 minutes
- Finally, Dry Ginger extract (2 mL) was incorporated with mixing for
2 minutes

2.4.4 Flavor and Sweetening

- Fresh lemon juice (3 mL) was added to the mixture and stirred for 1 minute.
- Stevia solution (5 mL) was incorporated with stirring for 1 minute.
- Honey (10 g) was added last and mixed thoroughly for 3 minutes to ensure complete distribution.

2.4.5 Volume Makeup and Final Processing

- The mixture was made up to a final volume of 100 mL with purified water and mixed for an additional 5 minutes to ensure homogeneity.
- The prepared syrup was filtered through multiple layers of muslin cloth to remove any potential particulate matter.
- The filtered syrup was filled into pre-sterilized amber-colored glass bottles, sealed properly, and labeled appropriately.

2.5 Evaluation Parameters

The formulated polyherbal syrup was evaluated for the following parameters:

2.5.1 Organoleptic Properties The syrup was evaluated for its appearance, color, odor, and taste by a panel of 5 trained individuals using descriptive analysis.

2.5.2 pH Determination The pH of the formulation was measured using a calibrated digital pH meter at room temperature (25°C ±

2°C). The target pH range was set at 5.0–6.0 to ensure stability and palatability.

2.5.3 Viscosity Measurement Viscosity was determined using a Brookfield viscometer with appropriate spindle at room temperature (25°C ± 2°C). The measurements were taken in triplicate, and the average value was recorded.

2.5.4 Specific Gravity Determination Specific gravity was measured using a pycnometer/hydrometer at room temperature (25°C ± 2°C). The measurement was performed in triplicate, and the average value was recorded.

2.5.5 Total Solid Content Total solid content was determined by the evaporation method: - 5 mL of the syrup was accurately measured and placed in a pre-weighed evaporating dish - The dish was heated on a water bath until the liquid component evaporated - The dish was then dried in an oven at 105°C until a constant weight was achieved - The percentage of total solids was calculated using the formula: % Total solids = (Weight of residue / Weight of sample) × 100

2.5.6 Microbial Limit Test The formulation was tested for microbial contamination using the standard plate count method as per pharmacopoeial guidelines: - Total aerobic microbial count (TAMC) - Total yeast and mold count (TYMC) - Tests for specific microorganisms (E. coli, Salmonella, S. aureus, P. aeruginosa)

2.5.7 Stability Study Short-term stability studies were conducted by storing the formulation under the following conditions: - Room temperature (25°C ± 2°C) - Refrigeration (4°C ± 2°C) - Accelerated conditions (40°C ± 2°C, 75% RH ± 5% RH) Samples were withdrawn at predetermined time intervals (0, 7, and 15 days) and evaluated for organoleptic properties, pH, viscosity, and microbial contamination.

3. RESULTS AND DISCUSSION

3.1 Formulation Development

The polyherbal syrup was successfully formulated by incorporating the four herbal extracts in an optimized base. Multiple trial batches were prepared with varying concentrations of sweeteners, viscosity enhancers, and preservatives to achieve the desired consistency, stability, and palatability. The final formulation was selected based on its optimal physicochemical properties and sensory attributes.

3.2 Organoleptic Evaluation

The organoleptic properties of the formulated polyherbal syrup are presented in Table 1:

Table 1: Organoleptic Properties of Polyherbal Syrup

Parameter	Observation
Appearance	Clear, slightly viscous liquid
Color	Dark brown with greenish tinge
Odor	Characteristic aromatic (predominantly of Tulsi and Ginger)
Taste	Sweet with slight pungency and herbal aftertaste
Consistency	Smooth, flowing

The organoleptic evaluation indicated that the formulation had acceptable sensory attributes. The combination of honey, stevia, and sorbitol effectively masked the bitter taste commonly associated with herbal extracts, resulting in a palatable preparation.

3.3 pH Determination

The pH of the formulation was found to be 5.6 ± 0.2, which falls within the target range of 5.0–6.0. This slightly acidic pH contributes to: - Stability of the herbal constituents - Enhanced preservative efficacy of sodium benzoate - Better palatability - Improved absorption of flavonoids and other bioactive compounds
The pH remained stable throughout the observation period, indicating good chemical stability of the formulation.

3.4 Viscosity Measurement

The viscosity of the polyherbal syrup was determined to be 135 ± 5 centipoises
(cP) at 25°C. This moderate viscosity is: - Suitable for a syrup formulation Appropriate for ease of pouring and measuring - Optimal for coating the throat (beneficial for local action) - Stable during the storage period

3.5 Specific Gravity Determination

The specific gravity of the formulated syrup was found to be 1.285 ± 0.012 at 25°C. This value is typical for syrup formulations containing sorbitol and glycerin as viscosity enhancers and is comparable to other marketed herbal syrups.

3.6 Total Solid Content

The percentage of total solids in the formulation was determined to be 38.75
± 1.25%. This relatively high solid content can be attributed to: - Dissolved extractives from herbal materials - Sweetening agents (honey, stevia, sorbitol) Viscosity enhancers (glycerin)
The moderate solid content contributes to the stability and physical characteristics of the syrup.

3.7 Microbial Limit Test

The results of the microbial limit tests are presented in Table 2:

Table 2: Microbial Evaluation of Polyherbal Syrup

Test	Specification	Result
Total aerobic microbial count	NMT 100 CFU/mL	35 CFU/mL
Total yeast and mold count	NMT 10 CFU/mL	3 CFU/mL
E. coli	Absent	Absent
Salmonella	Absent	Absent
S. aureus	Absent	Absent
P. aeruginosa	Absent	Absent

The formulation complied with the pharmacopoeial limits for microbial contamination, indicating: - Effectiveness of the preservation system - Good manufacturing practices during preparation - Suitable stability from a microbiological perspective

3.8 Stability Study

The results of the stability study are summarized in Table 3:

Table 3: Stability Study Results of Polyherbal Syrup

Initial Parameter(Day 0)	Room Temperature (Day 15)	Refrigeration (Day 15)	Accelerated (Day 15)
AppearancClear, slightly viscous	Clear, slightly viscous	Clear, slightly viscous	Slightly darker

pH 5.6 ± 0.2	5.5 ± 0.1	5.6 ± 0.1	5.3 ± 0.2
Viscosity 135 ± 5 cP)	138 ± 4	142 ± 6	130 ± 7
Microbial 35 count CFU/mL)	42	36	55

The stability studies indicated that the formulation remained physically and chemically stable under both room temperature and refrigerated conditions for the 15-day observation period. Under accelerated conditions, slight darkening of color and a minor decrease in pH were observed, suggesting potential chemical degradation of some constituents under stress conditions.

The formulation showed better stability under refrigeration, which is recommended for long-term storage.

4. DISCUSSION

4.1 Formulation Considerations

The development of this polyherbal syrup presented several formulation challenges that were successfully addressed:

- **Compatibility of herbal extracts**: The four herbal extracts were found to be physically compatible, with no visible precipitation or phase separation observed upon mixing.

- **Taste masking**: The inherent bitter taste of certain herbal constituents (particularly Giloy and Mulethi) was effectively masked using a combination of sweetening agents (honey, stevia, and sorbitol).

- **Preservation**: The combination of sodium benzoate as a chemical preservative, slightly acidic pH, and the natural antimicrobial properties of honey and some herbal constituents provided adequate preservation against microbial contamination.

- **Stability**: The formulation demonstrated satisfactory physical, chemical, and microbiological stability under normal storage conditions, which is crucial for maintaining its therapeutic efficacy.

4.2 Potential Therapeutic Benefits

The formulated polyherbal syrup combines the traditional knowledge of medicinal plants with modern pharmaceutical technology. The potential therapeutic benefits of this formulation for respiratory health include:

- **Immunomodulation**: Tulsi and Giloy are known immunomodulators that can enhance the body's resistance to respiratory infections.

- **Anti-inflammatory effects**: All four herbs possess anti-inflammatory properties that can help reduce inflammation in the respiratory tract.

- **Antimicrobial action**: Tulsi, Mulethi, and Ginger have demonstrated antimicrobial activity against common respiratory pathogens.

- **Expectorant and mucolytic effects**: Mulethi and Ginger can help in loosening and expelling mucus from the respiratory passages.

- **Bronchodilation**: Some constituents of Tulsi and Ginger have mild bronchodilatory effects, which can ease breathing difficulties.

- **Antioxidant protection**: The rich phytochemical profile of the herbs provides antioxidant protection against oxidative stress-induced damage to respiratory tissues.

4.3 Limitations and Future Directions

While the current study successfully developed and characterized a polyherbal syrup for

respiratory health, several limitations and future research directions should be acknowledged:

- **Standardization of bioactive markers**: Future studies should focus on identifying and quantifying specific bioactive markers in each herbal extract to ensure batch-to-batch consistency.

- **Long-term stability studies**: Extended stability studies (6 months to 1 year) are required to establish a definitive shelf life for the formulation.

- **In vitro and in vivo efficacy studies**: Pharmacological studies to evaluate the actual efficacy of the formulation against respiratory conditions are necessary.

- **Clinical trials**: Human clinical trials would be essential to establish the safety and efficacy of the formulation in the target population.

- **Dose optimization**: Studies to determine the optimal dose for various age groups and conditions would enhance the therapeutic utility of the formulation.

5. CONCLUSION

This research successfully developed and characterized a polyherbal syrup containing Tulsi, Mulethi, Giloy, and Dry Ginger extracts for respiratory health. The formulation exhibited satisfactory physicochemical properties, stability, and sensory attributes. The syrup combines the traditional medicinal properties of these herbs in a scientifically formulated dosage form suitable for modern use.

The formulation offers a potential natural alternative for respiratory health maintenance and could be particularly beneficial for conditions characterized by inflammation, infection, and compromised immunity in the respiratory tract. However, further pharmacological and clinical studies are warranted to substantiate the therapeutic claims and establish the optimal dosage regimen.

This study contributes to the growing field of evidence-based herbal formulations and demonstrates the potential of combining traditional herbal wisdom with modern pharmaceutical technology to develop effective, stable, and acceptable herbal medications.

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