"Development and Physicochemical Evaluation of a Polyherbal Cough Syrup"

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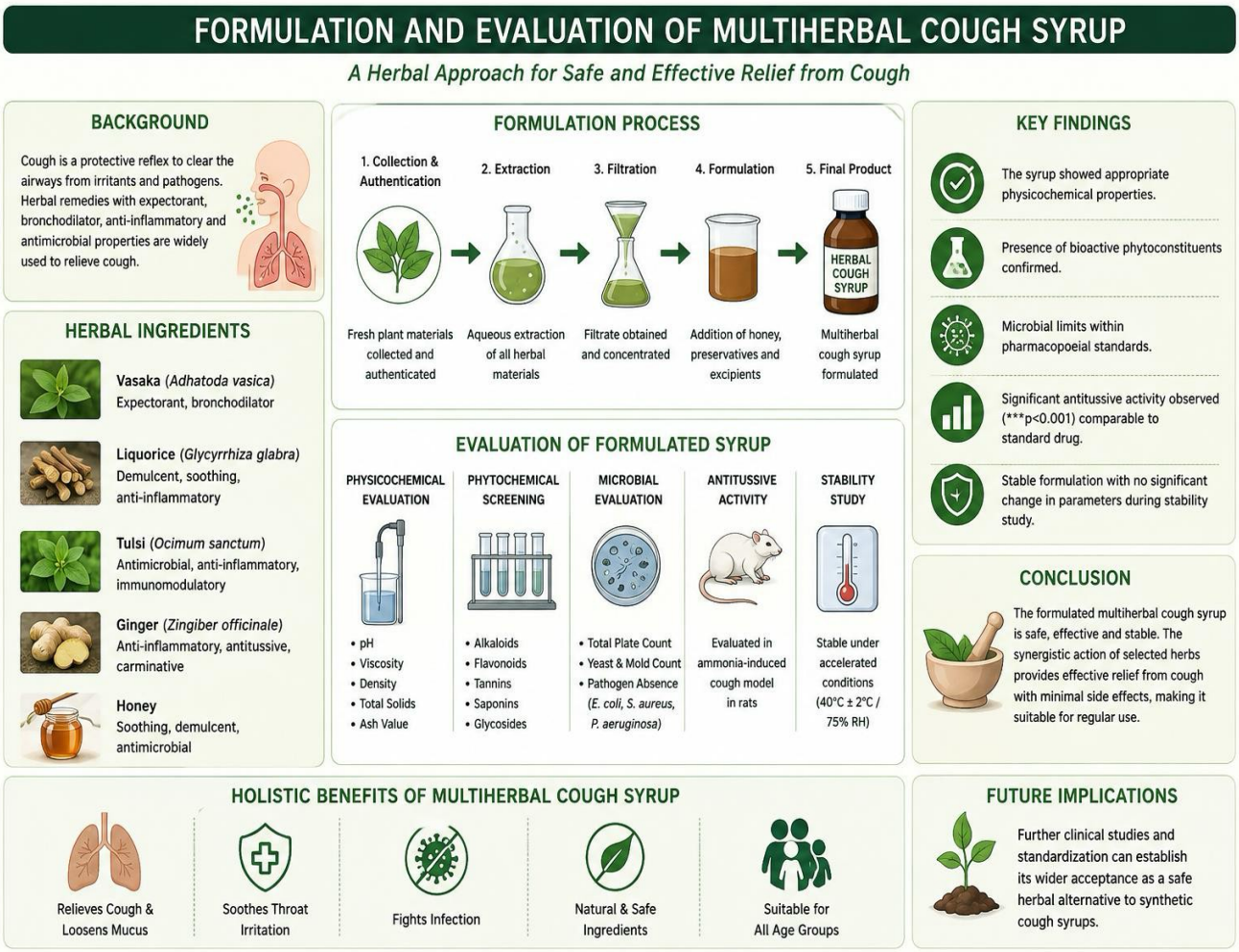
ABSTRACT

Background: Cough is a common respiratory symptom. The present study aimed to develop and evaluate a polyherbal cough syrup containing *Adhatoda vasica*, *Zingiber officinale*, *Glycyrrhiza glabra*, *Ocimum sanctum* and honey.

Materials and Methods: Herbal extracts were prepared by suitable aqueous, hydroalcoholic and ethanolic extraction methods. The extracts were incorporated into a syrup base, and two formulations (F1 and F2) were prepared. The formulations were evaluated for organoleptic properties, pH, viscosity, density, solubility and preliminary phytochemical characteristics.

Results: Liquorice showed the highest water-soluble extractive value (23%), while ginger showed the highest ethanol-soluble extractive value (16%). F1 and F2 were brownish-red, aromatic, sweet and clear. Their pH values were 6.65 and 6.56, viscosity values were 0.080 and 0.076, and density values were 1.12 and 1.22, respectively. Both formulations were soluble in water, ethanol and methanol.

Conclusion: The developed polyherbal cough syrup exhibited satisfactory organoleptic and physicochemical characteristics and provides a promising basis for further standardization and evaluation.



Keywords: Polyherbal formulation; Herbal cough syrup; *Adhatoda vasica*; *Zingiber officinale*; *Glycyrrhiza glabra*; *Ocimum sanctum*; Honey; Physicochemical evaluation.

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INTRODUCTION

Cough is a protective reflex that assists in clearing mucus, secretions, irritants and foreign particles from the respiratory tract. It may occur as a consequence of respiratory infections, allergic conditions, environmental pollutants, smoking, asthma, gastroesophageal reflux and other underlying disorders. Depending upon duration, cough may broadly be classified as acute, subacute or chronic.[1]

Conventional cough preparations commonly contain antitussive, expectorant, mucolytic or bronchodilator agents. Although these agents may provide symptomatic relief, their use may be associated with limitations depending on the active drug, dose and patient characteristics. Consequently, medicinal plants and traditional formulations have continued to receive attention as potential sources of supportive therapies.[2]

Herbal formulations are particularly attractive because several medicinal plants contain multiple classes of bioactive constituents. However, herbal medicines require appropriate identification, quality control, standardization and evaluation to ensure reproducible quality. WHO emphasizes that herbal medicinal products should undergo suitable quality-control procedures and that quality, safety and efficacy need to be appropriately considered[3]

The present formulation combines five traditionally used ingredients: Vasaka (*Adhatoda vasica*), Ginger (*Zingiber officinale*), Liquorice (*Glycyrrhiza glabra*), Tulsi (*Ocimum sanctum*) and honey. According to the thesis, Vasaka was selected for its traditional expectorant, antitussive and antimicrobial applications; ginger for antitussive and related respiratory applications; liquorice as an expectorant and demulcent; Tulsi for antioxidant and respiratory applications; and honey as a sweetening, emollient and viscosity-modifying component.[4]

Adhatoda vasica is a medicinal plant widely investigated for phytochemical constituents and pharmacological activities, including respiratory applications. The plant contains quinazoline alkaloids such as vasicine and related constituents.

Ginger contains phenolic constituents such as gingerols and shogaols together with volatile constituents. The thesis identifies ginger as one of the major herbal ingredients selected for the formulation.[5]

Liquorice contains glycyrrhizin, liquiritin, glabridin and related constituents and has traditionally been used as a flavouring, demulcent and expectorant ingredient.

Tulsi contains constituents including eugenol, ursolic acid, rosmarinic acid and other phytochemicals and has a long history of traditional use.[6]

Honey contains sugars, phenolic compounds, flavonoids and enzymes and is widely used as a soothing ingredient in cough preparations.

Therefore, the present investigation was designed to develop a polyherbal cough syrup using these ingredients and to assess its physicochemical quality characteristics.[7]

1. MATERIALS AND METHODS

1.1 Herbal Materials

The herbal materials selected for the formulation were:

Sr. No.	Herbal ingredient	Botanical name	Intended role
1	Vasaka	*Adhatoda vasica*	Expectorant, antitussive
2	Ginger	*Zingiber officinale*	Antitussive,
3	Liquorice	*Glycyrrhiza glabra*	Expectorant, demulcent
4	Tulsi	*Ocimum sanctum*	Antioxidant,
5	Honey	*Apis mellifera* product	Sweetener, emollient, base component

The ingredient-selection information corresponds to the formulation described in the thesis.

1.2 Equipment

The principal equipment used included mixer, digital weighing balance, pH meter, hot-air oven, sonicator and Brookfield viscometer.

1.3 Preparation of Herbal PowdersThe herbal materials were separately powdered using a mixer. The powdered materials were passed through sieve No. 80 to obtain relatively uniform material and were collected separately for further extraction.[8]

Fig no. 1 Herbal drugs used for the preparation of Herbal Extract

1.4 Preparation of Vasaka Extract

Twenty-five grams of dried Vasaka powder were transferred to a beaker containing 250 mL distilled water. The mixture was heated on a water bath at approximately 80–100°C for 3 h with occasional stirring. The hot mixture was filtered through muslin cloth and the filtrate was concentrated until the volume was reduced to approximately 50 mL. The concentrated extract was transferred to an airtight container for subsequent formulation.[9]

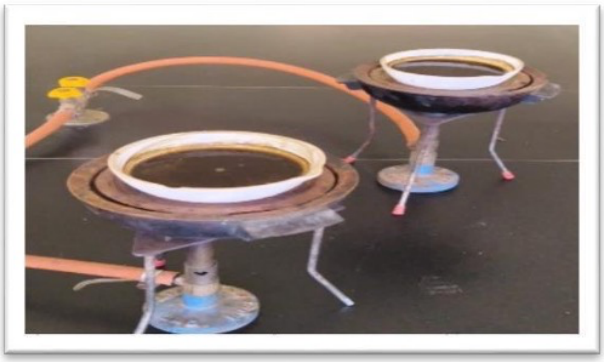

Fig no. 2 Preparation of Vasaka Extract

1.5 Preparation of Ginger Extract

Ten grams of dried ginger powder were transferred into an iodine flask and extracted using a hydroalcoholic solvent containing ethanol and water in a 70:30 ratio. The material was macerated for 72 h at room temperature with occasional shaking. The extract was filtered and the alcohol was removed by evaporation on a water bath at a temperature not exceeding 60°C to obtain a concentrated extract.[10]

Fig no. 3 Preparation of Ginger Extract

1.6 Preparation of Liquorice Extract

Twenty-five grams of liquorice powder were extracted with 250 mL hydroalcoholic solvent. The mixture was heated on a water bath at approximately 60–70°C for 3 h with occasional stirring. After filtration, the extract was concentrated at 60–70°C until a thick semisolid mass was obtained[11].

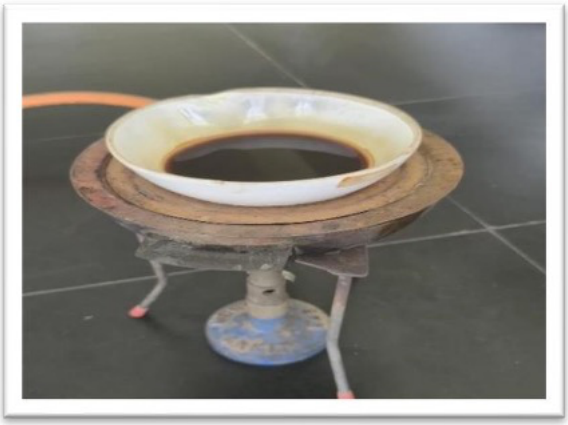

Fig no. 4 Preparation of Liquorice Extract

1.7 Preparation of Tulsi Extract

Fifty grams of dried Tulsi powder were placed in a Soxhlet extractor. pproximately 500 mL of 70% ethanol was used as extraction solvent. Extraction was continued for approximately 6–8 h or until the siphoning solvent became substantially colourless. The extract was filtered and concentrated on a water bath at a temperature not exceeding 60°C to obtain a semisolid extract.[12]

Fig no. 5 Preparation of Tulsi Extract

2. FORMULATION DEVELOPMENT

Two principal formulations were prepared by incorporating the concentrated herbal extracts into a syrup base.

Table 1. Composition of Polyherbal Cough Syrup Formulations

Ingredient	F1	F2
Vasaka extract	10 mL	10 mL
Ginger extract	5 mL	5 mL
Liquorice extract	5 mL	5 mL
Tulsi extract	5 mL	5 mL
Honey	10 mL	10 mL
Simple syrup	55 mL	55 mL
Glycerine	5 mL	5 mL
Sodium benzoate	0.2 g	0.2 g
Peppermint oil	q.s.	q.s.
HPMC	2 g	—
Distilled water	q.s. to 100 mL	q.s. to 100 mL

The thesis specifies F1 as containing HPMC and F2 without HPMC, while the simple syrup systems differed in the stated sucrose basis.

3. METHOD OF PREPARATION OF FINAL SYRUP

The concentrated herbal extracts were allowed to cool below approximately 40°C. Honey was then incorporated slowly with mixing. Glycerine was added, followed by sodium benzoate previously dissolved in a small quantity of water. HPMC and peppermint oil were incorporated as specified for the formulation, followed by simple syrup. Distilled water was added to make the final volume up to 100 mL.

The prepared formulation was visually examined for clarity and solubility. The final syrup was filled into well-closed amber-coloured glass containers to protect the preparation from light and moisture and stored under cool and dry conditions.

Fig no 6. Final herbal cough syrup

4. PREFORMULATION STUDIES

4.1 Determination of Moisture Content

Two grams of each sample were accurately weighed into a petri dish and heated in a hot-air oven at 100°C for 1 h. The sample was cooled and reweighed. Moisture content was calculated from the loss in weight.[13]

4.2 Water-Soluble Extractive Value

Five grams of air-dried material were mixed with 100 mL chloroform water and allowed to stand for 24 h with intermittent shaking during the initial period. After filtration, a measured portion of the filtrate was evaporated to dryness and dried at 105°C before weighing.[14]

4.3 Ethanol-Soluble Extractive Value

Five grams of air-dried material were extracted with 100 mL ethanol for 24 h. After filtration, 25 mL of filtrate was evaporated, dried at 105°C and weighed to calculate the ethanol-soluble extractive value.[15]

5. PHYTOCHEMICAL SCREENING

Preliminary phytochemical screening was carried out for selected herbal extracts.

For Vasaka, qualitative alkaloid tests including Dragendorff's, Hager's, Mayer's and Wagner's tests were performed. The thesis reports characteristic precipitate reactions indicating possible presence of alkaloids.[16]

For ginger, qualitative tests for phenolic constituents included iodine, ferric chloride, gelatin and lead acetate tests.

Liquorice was subjected to tests for saponins, flavonoids, terpenoids and reducing sugars. Tulsi was evaluated using qualitative tests for phenolic compounds.These preliminary tests provide qualitative evidence for classes of phytoconstituents but should not be interpreted as quantitative chemical standardization.[17]

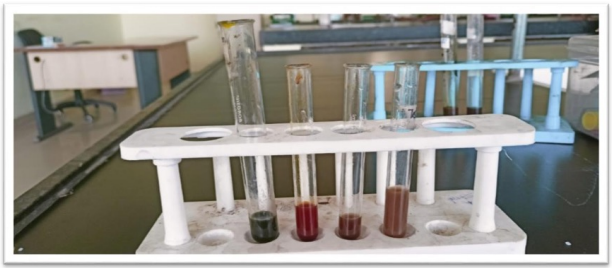

Fig no 7. Phytochemical Screening

6. EVALUATION OF HERBAL COUGH SYRUP

The prepared formulations were evaluated for:

1. Colour
2. Odour
3. Taste
4. Appearance
5. pH
6. Viscosity
7. Density
8. Solubility
9. Stability

These evaluation parameters are reported in the thesis.

6.1 Organoleptic Evaluation

Approximately 2 mL of syrup was examined against a white background under suitable illumination for colour. Odour was evaluated individually, while taste and appearance were assessed for the prepared formulations.[18]

6.2 Determination of pH

Ten millilitres of syrup were transferred into a 100 mL volumetric flask and diluted with distilled water. The preparation was sonicated for approximately 10 min and pH was measured using a digital pH meter.[19]

6.3 Density Determination

A clean, dry specific-gravity bottle was weighed. The bottle was subsequently filled with distilled water and weighed. It was then filled with the test sample and weighed.

The density/specific gravity was calculated using the corresponding mass relationships.[20]

6.4 ViscosityViscosity

was evaluated using a viscometric method as described in the thesis. The flow time of water and the sample was recorded and the relative viscosity was calculated using density and flow-time relationships.[21]

6.5 Solubility Study

The formulated syrup was evaluated in different solvents to characterize its solubility behaviour.[22]

6.6 Stability Study

The thesis describes a short-term temperature-based stability observation in which the formulated syrup was stored at 4°C, room temperature and 47°C. Changes in colour, odour, taste and turbidity were observed after 24, 48 and 72 h.[23]

7. RESULTS

7.1 Preformulation Results

Table 2. Preformulation Characteristics of Herbal Materials

Herbal material	Moisture content (%)	Water-soluble extractive (%)	Ethanol-soluble extractive (%)
Vasaka	2	9	11
Ginger	6	12	16
Liquorice	6	23	14
Tulsi	7	15	13
Honey	18	—	—

The results show that liquorice exhibited the highest water-soluble extractive value of 23%, whereas ginger showed the highest ethanol-soluble extractive value of 16%. Honey showed the highest moisture content at 18%.

Discussion

The differences in extractive values among the herbal materials may be associated with differences in their phytochemical composition and relative affinity of constituents for polar and hydroalcoholic solvents. The comparatively higher water-soluble extractive value of liquorice suggests the presence of a greater proportion of water-soluble constituents under the test conditions. Similarly, the higher ethanol-soluble extractive value of ginger indicates comparatively greater extraction of ethanol-soluble constituents.

The observed moisture values provide preliminary information regarding the quality and handling characteristics of the raw materials. However, moisture content alone is not sufficient to establish complete identity or purity of herbal materials. WHO quality-control guidance emphasizes the use of suitable quality-control procedures for herbal materials, including appropriate assessment of identity, purity and contaminants

7.2 Organoleptic and Physicochemical Evaluation

Table 3. Evaluation of Polyherbal Cough Syrup

Parameter	F1	F2	Marketed formulation
Colour	Brownish red	Brownish red	Brownish red
Odour	Aromatic	Aromatic	Aromatic
Taste	Sweet	Sweet	Sweet
Appearance	Clear	Clear	Clear
pH paper	Neutral	Neutral	Neutral
pH meter	6.65	6.56	6.72
Viscosity	0.080	0.076	0.078
Density	1.12	1.22	1.25

The thesis reports that both formulations exhibited satisfactory organoleptic properties and physicochemical characteristics and were comparable to the marketed formulation for the reported parameters.

Discussion of pH

The pH values of F1 and F2 were 6.65 and 6.56, respectively. The values were close to neutral and were relatively close to the reported marketed formulation value of 6.72.

The small difference between F1 and F2 may be related to differences in formulation composition, particularly the presence or absence of HPMC and the corresponding syrup system. The results indicate that both preparations exhibited similar pH characteristics under the conditions used in the study.

Discussion of Viscosity

The reported viscosity values for F1 and F2 were 0.080 and 0.076, respectively. F1 showed a slightly higher value than F2. This difference may be associated with the presence of HPMC in F1, as polymeric viscosity modifiers can influence the rheological behaviour of liquid formulations.

The reported marketed formulation value was 0.078, placing both experimental formulations in a comparable range according to the thesis data.

Discussion of Density

F1 and F2 showed density values of 1.12 and 1.22, respectively, while the marketed formulation showed a value of 1.25.

The difference between F1 and F2 may be related to the composition of the syrup base, dissolved solids, herbal extracts and viscosity-modifying components. The values demonstrate that the formulated products had measurable and reproducible density characteristics under the test conditions.

7.3 Solubility Results

Table 4. Solubility Profile

Solvent	Observation
Water	Soluble
Ethanol	Soluble
Methanol	Soluble
Chloroform	Insoluble

Acetone	Insoluble

The formulation was soluble in water, ethanol and methanol but insoluble in chloroform and acetone.

Discussion

The observed solubility behaviour indicates a predominance of constituents capable of interacting with polar solvents. Because the formulation contains aqueous/hydroalcoholic herbal extracts, honey, glycerine and syrup components, substantial solubility in polar media is expected. The solubility profile may also be useful for preliminary characterization of the final preparation.

7.4 Phytochemical Screening Results

Preliminary qualitative screening indicated possible presence of different phytochemical classes in the selected herbal materials, including alkaloids in Vasaka, phenolic compounds in ginger and Tulsi, and saponins, flavonoids, terpenoids and reducing sugars in liquorice.

Discussion

The presence of multiple phytochemical classes supports the rationale for investigating a polyherbal formulation. Nevertheless, preliminary colour and precipitation reactions are only screening procedures. They cannot establish exact concentrations, purity or therapeutic potency. For a stronger Scopus-targeted manuscript, future work should include chromatographic fingerprinting and quantitative estimation of suitable marker compounds.

8. STABILITY OBSERVATIONS

The formulation was subjected to short-term temperature-based observation at 4°C, room temperature and 47°C, with observations recorded at 24, 48 and 72 h for parameters including colour, odour, taste and turbidity.

The study was intended to monitor visible physicochemical changes during storage under different temperature conditions. Based on the thesis conclusion, the formulations showed satisfactory characteristics during the reported evaluation period.

9. NOVELTY AND SCIENTIFIC SIGNIFICANCE

The scientific value of the present study lies primarily in the **development and comparative physicochemical evaluation of a multi-herbal syrup using five traditionally used ingredients**, together with individual extraction procedures andpreliminary quality evaluation.

The formulation combines:

- *Adhatoda vasica* – traditional expectorant/antitussive ingredient
- *Zingiber officinale* – traditional respiratory and soothing ingredient
- *Glycyrrhiza glabra* – demulcent/expectorant ingredient
- *Ocimum sanctum* – traditional respiratory/antioxidant ingredient
- Honey – sweetening and soothing vehicle component

The thesis demonstrates that the resulting formulations can be prepared as clear, sweet, aromatic syrup preparations with measurable pH, viscosity and density characteristics.

10. LIMITATIONS OF THE STUDY

The present study has several limitations:

1. Only two formulation compositions are reported in the formulation table.
2. Quantitative estimation of individual marker compounds was not performed.
3. No HPLC/UPLC fingerprinting was reported.
4. No microbial-limit testing was reported.
5. No preservative-efficacy testing was reported.
6. No quantitative antitussive pharmacological study was performed.
7. No animal or clinical study was performed.
8. The reported stability observation was short-term and temperature-based.
9. Statistical analysis of replicate physicochemical measurements was not reported.
10. The viscosity unit is not specified in the thesis table.
11. The preliminary phytochemical tests are qualitative rather than quantitative.

11. FUTURE SCOPE

Future studies should include:

1. HPLC/UPLC fingerprinting of the final formulation.
2. Quantification of appropriate marker compounds such as vasicine, selected ginger phenolics and glycyrrhizin.
3. Total phenolic and total flavonoid content estimation.
4. Microbial-limit testing.
5. Preservative efficacy testing.
6. Long-term and accelerated stability studies.
7. Rheological characterization at different shear rates.
8. In-vitro antioxidant evaluation.
9. In-vitro antimicrobial studies where scientifically justified.
10. Preclinical pharmacological evaluation.
11. Toxicological evaluation.
12. Scale-up and process optimization.
13. Packaging compatibility studies.
14. Development of validated quality-control specifications.

12. CONCLUSION

A polyherbal cough syrup containing *Adhatoda vasica*, *Zingiber officinale*, *Glycyrrhiza glabra*, *Ocimum sanctum* and honey was successfully developed using individual extraction procedures and a syrup-based formulation approach.

The prepared formulations exhibited acceptable organoleptic characteristics, with brownish-red colour, aromatic odour, sweet taste and clear appearance. F1 and F2 showed pH values of 6.65 and 6.56, respectively, while their reported viscosity values were 0.080 and 0.076 and density values were 1.12 and 1.22, respectively. The formulations were soluble in water, ethanol and methanol and insoluble in chloroform and acetone.

The preformulation investigation demonstrated

variation in moisture and extractive values among the herbal ingredients, with liquorice showing the highest water-soluble extractive value and ginger showing the highest ethanol-soluble extractive value.

13. ACKNOWLEDGEMENT

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