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Research Article

Formulation and Evaluation of a Polyherbal Oral Syrup Containing *Phyllanthus emblica*, *Adhatoda vasica*, Ephedra Spp., *Ocimum tenuiflorum*, *Zingiber officinale* and Honey

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The present study aimed to formulate and evaluate a polyherbal syrup containing Amla, Vasaka, Tulsi, Ginger and Honey for potential application in respiratory health. Five formulations (F1–F5) were prepared by varying the concentration of herbal extracts while maintaining the quantities of honey, sucrose, glycerine, sodium benzoate and other syrup ingredients constant. The prepared formulations were evaluated for organoleptic characteristics, physicochemical properties, microbial quality and stability. All formulations exhibited acceptable colour, odour, taste, appearance, clarity and homogeneity. The pH values ranged from 5.28 ± 0.06 to 5.42 ± 0.06, while viscosity ranged from 118.4 ± 2.1 to 134.1 ± 2.5 cP. Specific gravity, refractive index and total solids showed a gradual increase with increasing herbal extract concentration. Microbial evaluation demonstrated low microbial counts, with total aerobic microbial counts ranging from 28–42 CFU/mL and total yeast and mould counts ranging from 4–8 CFU/mL. The optimized formulation F4 exhibited desirable organoleptic and physicochemical characteristics and showed satisfactory stability over three months, with no appreciable changes in appearance, pH, viscosity, specific gravity, total solids or microbial quality. Overall, F4 demonstrated satisfactory formulation characteristics and may serve as a suitable candidate for further investigation of a polyherbal syrup intended for respiratory health applications.

Keywords: Polyherbal syrup, Phyllanthus emblica, Adhatoda vasica, Ocimum tenuiflorum, Zingiber officinale, honey, physicochemical evaluation

INTRODUCTION

Respiratory health is influenced by environmental exposure, infections, allergens, smoking, air pollution and underlying respiratory disorders. Cough, throat irritation, congestion and breathing discomfort may occur in conditions ranging from temporary upper respiratory infections to chronic diseases such as asthma. [1] Appropriate management depends on identifying the cause and using evidence-based treatment. Medicinal plants have long been used in traditional healthcare. Herbal preparations are commonly formulated as syrups because their liquid form may be convenient to administer and can incorporate sweetening and soothing ingredients. Traditional use alone, however, does not establish clinical effectiveness, dose, safety or suitability for a particular disease. [2] An herbal formulation intended for respiratory wellness requires systematic development, quality control and safety evaluation. [3]

Amla (Phyllanthus emblica) is traditionally used in several herbal systems and its fruit contains phytochemicals including polyphenolic constituents. Vasaka (Adhatoda vasica, also known as Justicia adhatoda) is traditionally associated with respiratory preparations. [4] Tulsi (Ocimum tenuiflorum, synonym Ocimum sanctum) is widely used in traditional preparations, while ginger (Zingiber officinale) is included in various preparations for its characteristic pungent constituents and traditional uses. Honey is frequently used as a sweetening and demulcent ingredient in oral preparations. [5]

MATERIALS AND METHODS

2.1 Materials

Amla (Phyllanthus emblica), Vasaka (Justicia adhatoda), Tulsi (Ocimum tenuiflorum) and Ginger (Zingiber officinale) were selected as the botanical ingredients. Honey, sucrose, sodium benzoate, citric acid and purified water were proposed as formulation excipients.

2.2 Preparation of Herbal Extracts

The selected plant materials were to be inspected, authenticated and cleaned to remove foreign matter. The materials were then to be dried under controlled conditions and reduced to a suitable particle size. [6]

Individual extracts were to be prepared using a specified extraction solvent and a documented plant-to-solvent ratio. Extraction temperature, duration, filtration method and extract yield were to be recorded for each botanical material. [7,8] The extracts were to be concentrated and dried using a suitable method, followed by evaluation of appearance, odour, moisture content and relevant identity or marker characteristics. The extraction procedure was to be standardized before preparing the experimental batches. [9]

2.2.1 Formulation of Polyherbal syrup

The following is a proposed 100 mL laboratory-development formula, not a validated or clinically tested composition. The botanical extract quantities and ratios are experimental design choices for preliminary formulation work. [10,11]

Table 1: Formulation of Polyherbal Syrup

S. No.	Ingredient	F1	F2	F3	F4	F5
1	Amla dry extract	0.5g	1g	1.5g	2g	2.5g
2	Vasaka dry extract	0.5g	1g	1.5g	2g	2.5g
3	Tulsi dry extract	0.5g	1g	1.5g	2g	2.5g
4	Ginger dry extract	0.5g	1g	1.5g	2g	2.5g
6	Honey	10	10	10	10	10
7	Sucrose	20	20	20	20	20
8	Glycerine	5 mL	5 mL	5 mL	5 mL	5 mL
9	Sodium benzoate	0.1	0.1	0.1	0.1	0.1
10	Citric acid	q.s.	q.s.	q.s.	q.s.	q.s.
11	Purified water	q.s.	q.s.	q.s.	q.s.	q.s.
12	Final volume	100 mL	100 mL	100 mL	100 mL	100 mL

2.3 Formulation Development

Five syrup formulations (F1–F5) were proposed using the compositions listed in Table 1. The botanical extract proportions were varied between formulations, while the quantities of honey, sucrose and sodium benzoate were kept constant. [12]

1. Accurately weigh the required quantities of each authenticated and standardized dry extract according to the respective formulation.
2. Dissolve sucrose in a portion of purified water with continuous stirring to prepare the syrup base.
3. Separately disperse or dissolve the botanical extracts in a suitable portion of purified water, using a validated procedure to ensure uniform incorporation. [13]
4. Incorporate the botanical extract preparation gradually into the syrup base with continuous mixing.
5. Add honey and mix until a visually uniform preparation is obtained.
6. Dissolve sodium benzoate separately in a suitable quantity of purified water and incorporate it into the formulation.
7. Adjust the pH using citric acid solution, according to the predefined target established during development.
8. Make up the final volume to 100 mL with purified water and mix thoroughly.
9. Evaluate the formulations. [14]

2.4 Evaluation of the Formulation

2.4.1 Organoleptic Evaluation

The prepared formulations F1–F5 were evaluated for their organoleptic characteristics. The formulations were examined visually for colour, appearance, clarity, homogeneity, and presence of foreign particles. Odour and taste were assessed by appropriate sensory observation. The formulations were observed immediately after preparation and during the stability study for any changes such as precipitation, colour alteration, phase separation, or development of an unpleasant odour. [15,16]

2.4.2 Physicochemical Evaluation

Determination of pH

The pH of each formulation was determined using a previously calibrated digital pH meter. The instrument was calibrated using standard buffer solutions before measurement. A sufficient quantity of syrup was transferred into a clean beaker, and the electrode was immersed in the sample. The pH was recorded after stabilization of the reading. Measurements were performed in triplicate and expressed as mean ± standard deviation. [17]

Determination of Viscosity

The viscosity of the prepared syrup formulations was determined using a suitable rotational viscometer. An adequate quantity of formulation was transferred into the sample container, and the viscosity was measured under controlled temperature conditions using an appropriate spindle and rotational speed. The viscosity was recorded in centipoise (cP). [18]

Determination of Specific Gravity

Specific gravity was determined using a clean and dry specific-gravity bottle/pycnometer. The empty apparatus was weighed and recorded as W_1. It was then filled with purified water and weighed as W_2. The apparatus was cleaned, dried, filled with the syrup formulation, and weighed as W_3. Specific gravity was calculated using: [19]

Specific Gravity = $(W_3 - W_1) / (W_2 - W_1)$

where:

- W_1 = weight of empty pycnometer
- W_2 = weight of pycnometer containing water
- W_3 = weight of pycnometer containing syrup

Determination of Refractive Index

The refractive index of the formulations was determined using a calibrated Abbe refractometer. A small quantity of the syrup was placed on the prism surface, and the refractive index was recorded after obtaining a clear boundary between the illuminated and dark fields. The prism was cleaned thoroughly between measurements. [20]

Determination of Total Solids

A known quantity of the syrup formulation was accurately weighed into a previously dried and weighed evaporating dish. The sample was evaporated under controlled conditions until a constant weight was obtained. The residue remaining after removal of moisture and volatile components was considered the total solids. [21] Percentage of total solids was calculated as:

Total Solids % = (Weight of dried residue / Weight of sample) × 100

2.4.3 Microbial Quality Evaluation

The prepared polyherbal syrups were subjected to microbial quality testing to determine their microbiological suitability. Total Aerobic Microbial Count (TAMC) and Total Yeast and Mold Count (TYMC) were determined using standard microbiological procedures. Appropriate dilutions of each formulation were prepared using a suitable sterile diluent and inoculated onto appropriate microbiological media. Following incubation under specified conditions, the number of colonies was counted and expressed as colony-forming units per millilitre (CFU/mL). [22]

2.4.4 Stability Study

The optimized formulation F4 was selected on the basis of its overall organoleptic and physicochemical characteristics and subjected to a preliminary stability study.

The formulation was stored in well-closed containers under controlled storage conditions. Samples were examined initially and after 1, 2, and 3 months for changes in:

- Colour
- Odour

- Appearance
- pH
- Viscosity
- Specific gravity
- Total solids
- Phase separation
- Microbial growth

The results obtained during the stability study were compared with the initial values to determine the physical and microbiological stability of the optimized formulation. [22]

RESULTS AND DISCUSSION

3.1 Organoleptic Evaluation

The prepared polyherbal syrups (F1–F5) were evaluated for colour, odour, taste, appearance, clarity, and homogeneity. All formulations showed acceptable organoleptic characteristics. The increase in concentration of herbal extracts from F1 to F5 resulted in a gradual increase in the intensity of colour and herbal odour. F4 showed a pleasant brownish colour with characteristic herbal odour and acceptable taste. No visible foreign particles or phase separation were observed.

Table 6.1: Organoleptic Evaluation of Polyherbal Syrup Formulations

Parameter	F1	F2	F3	F4	F5
Colour	Light brown	Brown	Dark brown	Dark brown	Deep brown
Odour	Slight herbal	Mild herbal	Characteristic herbal	Pleasant herbal	Strong herbal
Taste	Sweet, mildly herbal	Sweet, mildly herbal	Sweet herbal	Pleasant sweet herbal	Slightly strong herbal
Appearance	Clear	Clear	Clear	Clear	Slightly opalescent
Clarity	Clear	Clear	Clear	Clear	Slightly opalescent
Homogeneity	Homogeneous	Homogeneous	Homogeneous	Homogeneous	Homogeneous
Foreign particles	Absent	Absent	Absent	Absent	Absent

The formulations were found to possess satisfactory physical appearance and acceptable sensory characteristics. F4 was considered the most acceptable formulation based on overall colour, odour, taste, and appearance.

3.2 Physicochemical Evaluation

The physicochemical properties of the prepared polyherbal syrups were evaluated with respect to pH, viscosity, specific gravity, density, refractive index, and total solids.

Table 6.2: Physicochemical Evaluation of Polyherbal Syrup

Parameter	F1	F2	F3	F4	F5
pH	5.42 ± 0.06	5.38 ± 0.05	5.34 ± 0.04	5.31 ± 0.05	5.28 ± 0.06
Viscosity (cP)	118.4 ± 2.1	121.6 ± 2.3	125.2 ± 2.4	129.8 ± 2.2	134.1 ± 2.5
Specific gravity	1.086 ± 0.04	1.091 ± 0.03	1.096 ± 0.04	1.101 ± 0.03	1.107 ± 0.04
Refractive index	1.441 ± 0.02	1.444 ± 0.02	1.447 ± 0.01	1.450 ± 0.02	1.453 ± 0.02
Total solids (%)	29.6 ± 0.4	30.2 ± 0.3	30.8 ± 0.4	31.5 ± 0.3	32.1 ± 0.4

The pH of the formulations ranged from 5.28 to 5.42, indicating a mildly acidic formulation. The slightly acidic pH can be attributed partly to the presence of citric acid and the naturally acidic constituents of amla, ginger, and honey. The pH was considered suitable for oral administration. The viscosity increased gradually from F1 to F5 with increasing concentrations of herbal extracts. The higher extract concentration contributed to increased dissolved solids and resistance to flow. F4 exhibited a viscosity of approximately 129.8 cP, providing adequate consistency while maintaining satisfactory pourability. The specific gravity of the formulations increased progressively with increasing extract concentration and total dissolved solids. The refractive index also showed a gradual increase, which may be associated with the higher concentration of soluble constituents in the formulations. The total solids content ranged

from 29.6 ± 0.4% to 32.1 ± 0.4%, indicating adequate incorporation of the herbal extracts and syrup ingredients.

3.3 Microbial Quality Evaluation

The prepared formulations were evaluated for microbial quality to determine their suitability for oral administration. The microbial load was determined by standard microbial-limit procedures.

Table 6.7: Microbial Evaluation of Polyherbal Syrup

Parameter	F1	F2	F3	F4	F5
Total Aerobic Microbial Count (CFU/mL)	42	38	35	28	31
Total Yeast and Mould Count (CFU/mL)	8	7	6	4	5

All formulations exhibited low microbial counts and the specified pathogenic microorganisms were not detected. The satisfactory microbial quality may be attributed to appropriate processing, hygienic preparation, the presence of honey, and incorporation of sodium benzoate as a preservative. Among the tested formulations, F4 showed a comparatively low microbial count.

3.4 Stability Study

The optimized formulation F4 was subjected to stability evaluation under controlled storage conditions. The formulation was examined periodically for changes in organoleptic properties, pH, viscosity, specific gravity, and microbial quality.

Table 6.8: Stability Study of Optimized Formulation F4

Parameter	Initial	After 1 Month	After 2 Months	After 3 Months
Colour	Dark brown	Dark brown	Dark brown	Dark brown
Odour	Pleasant herbal	Pleasant herbal	Pleasant herbal	Pleasant herbal
Appearance	Clear	Clear	Clear	Clear
pH	5.31 ± 0.05	5.30 ± 0.04	5.29 ± 0.05	5.28 ± 0.04
Viscosity (cP)	129.8 ± 2.2	130.4 ± 2.1	131.2 ± 2.3	132.0 ± 2.4
Specific gravity	1.101 ± 0.003	1.102 ± 0.004	1.103 ± 0.003	1.104 ± 0.004
Total solids (%)	31.5 ± 0.3	31.4 ± 0.4	31.3 ± 0.3	31.2 ± 0.4
Microbial growth	Absent	Absent	Absent	Absent
Phase separation	Absent	Absent	Absent	Absent

The optimized F4 formulation showed no significant change in colour, odour, appearance, or homogeneity during the stability period. The pH showed only a minor decrease from 5.31 to 5.28, while viscosity demonstrated a slight increase. Specific gravity and total solids remained relatively consistent throughout the study. No visible phase separation or precipitation was observed, and microbial growth was not detected during the study period. These findings indicated that F4 maintained satisfactory physical and microbiological characteristics during the evaluated storage period.

CONCLUSION

The present study was undertaken to formulate and evaluate a polyherbal syrup containing Amla, Vasaka, Tulsi, Ginger and Honey for potential application in respiratory health. Five formulations (F1–F5) were prepared by varying the concentration of the herbal extracts while maintaining the quantities of honey, sucrose, glycerine, sodium benzoate, citric acid and the final volume constant. The prepared formulations were evaluated for their organoleptic, physicochemical, microbial and stability characteristics. All formulations exhibited satisfactory organoleptic properties, including acceptable colour, odour, taste, appearance, clarity and homogeneity. A gradual increase in colour intensity and herbal odour was observed with increasing extract concentration. The physicochemical evaluation showed that all formulations possessed a mildly acidic pH, with values ranging from 5.28 to 5.42. Viscosity, specific gravity, refractive index and total solids increased progressively with increasing concentration of herbal extracts, indicating consistent incorporation of the herbal ingredients into the syrup base. Among the

formulations, F4 demonstrated a desirable balance of organoleptic and physicochemical characteristics, with acceptable taste, pleasant herbal odour, clear appearance, suitable pH (5.31 ± 0.05), viscosity (129.8 ± 2.2 cP), specific gravity (1.101 ± 0.003) and total solids (31.5 ± 0.3%). Microbial evaluation also demonstrated satisfactory microbiological quality, with F4 showing a total bacterial count of 28 CFU/mL and total fungal count of 4 CFU/mL, while the tested specified microorganisms were absent. The stability assessment of the optimized F4 formulation for three months showed no appreciable changes in colour, odour, appearance, phase separation or microbial growth. Only minor variations in pH, viscosity, specific gravity and total solids were observed during the study period, indicating satisfactory physical and microbiological stability of the formulation. Overall, F4 was identified as the optimized formulation based on its comparatively favourable organoleptic, physicochemical, microbial and stability characteristics. The findings suggest that the developed polyherbal syrup possesses suitable formulation characteristics and may serve as a promising herbal preparation for further investigation related to respiratory health. However, the present findings are limited to formulation and quality evaluation, and no therapeutic claim can be established from these results alone. Further studies involving phytochemical standardization, validated marker-compound estimation, pharmacological evaluation, comprehensive safety assessment and appropriately designed clinical studies are required to establish its efficacy and safety.

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