WORLD JOURNAL OF PHARMACEUTICAL RESEARCH
SJIF Impact Factor 8.453
Volume 14, Issue 11, 686-702. Research Article ISSN 2277–7105

FORMULATION AND DEVELOPMENT OF ANTI-TUSSIVE SYRUP

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Article Received on
13 April 2025,

Revised on 04 May 2025,
Accepted on 25 May 2025

DOI: 10.20959/wjpr202511-36961

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ABSTRACT

This study focuses on the development of a natural polyherbal cough syrup using extracts of Madhuca longifolia (Mahua), Adhatoda vasica (Adulsa), Syzygium aromaticum (Clove), Cinnamomum zeylanicum (Cinnamon), and honey each chosen for their established respiratory benefits. Mahua acts as the primary active pharmaceutical ingredient (API), contributing significant expectorant and soothing effects that aid in the clearance of bronchial secretions. The herbal extracts collectively exhibit synergistic antitussive, mucolytic, anti-inflammatory, and antimicrobial properties. Adhatoda vasica provides bronchodilatory and mucolytic actions through vasicine; Syzygium aromaticum offers analgesic and antimicrobial benefits via eugenol; Cinnamomum zeylanicum adds antitussive and antioxidant activity due to cinnamaldehyde; and honey acts as a natural demulcent, improving palatability and soothing the throat. The final syrup formulation underwent evaluation for organoleptic characteristics, physicochemical parameters, and microbial quality. Preliminary results indicate that the syrup is stable, palatable, and exhibits mild antimicrobial activity, suggesting potential effectiveness in managing both dry and productive cough. Further pharmacological validation and clinical studies are recommended to support its therapeutic use.

KEYWORDS: Madhuca longifolia, Anti-Tussive, Cough, Mucus, Evaluation, Soxhelet.

INRODUCTION

Herbal syrups are liquid dosage forms prepared by concentrating herbal extracts with natural sweetening agents like honey or sugar, and occasionally alcohol, to improve preservation and palatability. These formulations are widely used in traditional medicine systems for

managing various ailments, especially respiratory conditions such as cough.

The base of an herbal syrup is typically a strong herbal extract. When combined with honey or sugar, this not only enhances the taste but also increases the shelf life of the preparation. Medicinal plants have been used for centuries in the treatment of common ailments, and many are known for their cough-relieving properties. Ingredients like Mahua, Clove, Cinnamon, Adulsa, and Honey are well-documented for their soothing, expectorant, antimicrobial, and antioxidant effects, making them ideal for inclusion in an herbal cough formulation.[1]

Cough syrups are a preferred dosage form for patients who have difficulty swallowing tablets or capsules. The liquid form allows for easy administration and quick absorption of the active ingredients through the gastrointestinal tract.[2]

However, many synthetic cough syrups, though effective, are often associated with adverse effects such as drowsiness, dizziness, and gastric discomfort. This has led to a growing interest in herbal alternatives that offer therapeutic benefits without harmful side effects. The current research aims to develop a stable, effective, and natural herbal anti-tussive syrup using traditional medicinal plants. The formulation was evaluated for essential parameters including pH, viscosity, density, and stability, to ensure its effectiveness and quality.[3]

Herbal formulations, especially in liquid form, continue to play a significant role in both traditional and modern healthcare systems. This study emphasizes the importance of combining traditional knowledge with modern pharmaceutical techniques to create safe and efficient remedies for common ailments like cough.[4]

Cough

Cough represents a complex physiological reflex that serves as a primary defence mechanism of the respiratory tract, facilitating the clearance of irritants, secretions, and foreign matter from the airways. It may be classified based on duration and characteristics into acute or chronic, and more specifically, as productive (wet) or non-productive (dry) cough.[5]

A dry (non-productive) cough is characterized by the absence of sputum production and typically arises due to viral upper respiratory tract infections, allergen exposure, gastroesophageal reflux, or environmental pollutants. In contrast, a wet (productive) cough involves expectoration of mucus or sputum, often associated with bacterial infections,

bronchitis, or chronic inflammatory airway conditions such as chronic obstructive pulmonary disease (COPD).[6]

Mucus is secreted by goblet cells and submucosal glands within the airway epithelium and plays a critical role in trapping inhaled pathogens and particulates. This viscoelastic secretion is propelled toward the pharynx by coordinated ciliary activity for expectoration or deglutition. During respiratory infections, hypersecretion and increased viscosity of mucus are commonly observed, thereby necessitating effective clearance mechanisms such as coughing.

Preventive strategies include minimizing exposure to environmental and occupational irritants (e.g., tobacco smoke, allergens, and industrial pollutants), ensuring proper hydration, practicing respiratory hygiene, and adhering to immunization schedules (e.g., influenza and pneumococcal vaccines) to reduce the incidence of respiratory infections.[7]

Therapeutic interventions are guided by the etiology and nature of the cough. In cases of non-productive cough, centrally acting antitussives are employed to suppress the cough reflex. These agents, including codeine, dextromethorphan, and pholcodine, act primarily on the medullary cough center to reduce the frequency and severity of coughing. Conversely, productive coughs benefit more from the use of expectorants such as guaifenesin, which promote mucus thinning and clearance, rather than suppressing the reflex.[8]

MATERIALS AND METHOD OF PREPARATION

Following Herbal Ingredients were used in the formulation of herbal syrup

Mahua

Biological Source: Derived from the flowers of *Madhuca indica* (syn. *Madhuca longifolia*), a tree from the family Sapotaceae.

Figure 1: Mahua.

Chemical Constituents

Mahua flowers contain natural sugars such as glucose, fructose, and sucrose, along with triterpenoids. They also possess saponins and flavonoids.[9]

Uses

Mahua (Madhuca indica) exhibits anti-tussive activity, aiding mucus clearance in productive cough. Traditionally used as a tonic and nutritional supplement, it also shows soothing, anti-inflammatory, and antioxidant properties. Its flowers are fermented in some cultures, and the plant is valued in ethnomedicine for treating respiratory and inflammatory conditions.

Adulsa (Vasaka)

Biological Source: Adulsa consists of the leaves of *Justicia adhatoda* (synonym *Adhatoda vasica*), belonging to the family Acanthaceae.

Figure 2: Adulsa.

Chemical Constituents

The plant is rich in alkaloids such as vasicine, vasicinone, and. It also contains essential oils, tannins, saponins, and flavonoids.

Uses

Adulsa is widely known for its expectorant and bronchodilator effects, making it a common ingredient in herbal cough syrups. It exhibits antimicrobial, anti-inflammatory, and antispasmodic properties and has long been used in traditional medicine to manage respiratory conditions like asthma and bronchitis.[10]

Clove

Biological Source: Clove is the dried flower bud of *Syzygium aromaticum*, a member of the Myrtaceae family.

Figure 3: Clove.

Chemical Constituents

Its main active compound is eugenol (up to 76.8%), eugenyl acetate.

Uses

Clove is widely recognized for its analgesic and antiseptic effects, especially in dental care. It has strong antimicrobial and antioxidant properties, and is also used to manage digestive and respiratory issues. Additionally, clove oil and extracts are valued in the flavouring and fragrance industries.[11]

Cinnamon

Biological Source: Cinnamon is obtained from the bark of *Cinnamomum zeylanicum* (Ceylon cinnamon) or *Cinnamomum cassia*, both belonging to the family Lauraceae.

Figure 4: innamon.

Chemical Constituents

The bark contains cinnamaldehyde, cinnamic acid, eugenol, and, particularly in Cassia cinnamon, coumarin.

Uses

Known for its antioxidant, anti-inflammatory, and antimicrobial effects, cinnamon supports blood sugar regulation and cardiovascular health. It is widely used as a culinary spice and natural preservative. However, excessive intake of Cassia cinnamon may pose health risks due to its coumarin content.[12]

Honey

Biological Source: Honey is a natural product synthesized by bees (*Apis* species) from the nectar of flowers.

Figure 5: Honey.

Chemical Constituents

It primarily consists of sugars like fructose (38%), glucose (31%), maltose, and sucrose. Enzymes such as invertase, glucose oxidase, and catalase are also present, along with amino acids, vitamins (especially B-complex and vitamin C), minerals (e.g., calcium, iron, zinc), and antioxidant flavonoids.

Uses

Honey is known for its natural antibacterial and healing qualities. It is commonly used to relieve throat irritation and suppress cough, thanks to its soothing action that helps reduce discomfort. In traditional and modern therapies alike, honey serves as a natural remedy for

respiratory issues. It is also a key ingredient in many skincare products due to its ability to retain moisture and combat bacteria.[13]

Table 1: Formulation table of syrup.

Sr. No	Ingredients	Activity
1	Mahua	Anti-tussive
2	Adulsa	Expectorant
3	Cinnamon	Anti-oxidant
4	Clove	Anti-inflammatory
5	Honey	Base
6	Purified Water	Vehicle

Method of preparation of Extraction

The first step in researching medicinal plants involves preparing the plant materials in a way that preserves their bioactive compounds before extraction. Various parts of the plant such as leaves, bark, roots, fruits, and flowers can be used, either in their fresh form or after drying. Processes like drying and grinding play a crucial role, as they can significantly impact the stability and retention of phytochemicals in the final extract.[14]

Soxhlet Extraction of Mahua flowers and adulsa leaves

The Soxhlet extraction method was employed for obtaining phytoconstituents from Mahua flowers and Adulsa leaves. Initially, the air-dried plant materials were crushed and ground into coarse powder. A total of 50 g of the powdered sample was subjected to continuous extraction using 250 mL of methanol in a Soxhlet apparatus for a duration of 6 to 8 hours. Upon completion, the methanolic extracts were collected, filtered, and preserved for further phytochemical and formulation studies,[14,15]

Figure 6: Soxhlet Extraction of Mahua and Soxhlet Extraction of Adulsa.

Decoction of Clove and Cinnamon

A decoction of Clove and Cinnamon was prepared by mixing 5 g of clove bud powder and 5 g of Cinnamomum bark powder with 500 mL of purified water. The mixture was then subjected to boiling until the total volume was reduced to one-fourth of the original, allowing for concentration of the active constituents. After boiling, the decoction was allowed to cool to room temperature and subsequently filtered using a filter press to obtain a clear filtrate. This filtrate was used as a key component in the preparation of the final herbal syrup formulation.[1,16]

Figure 7: Decoction of Cinnamon and Decoction of Clove.

Method of preparation of herbal Syrup

For preparation of herbal syrup take honey and purified water in required amount for base preparation. Stir it for 5-10minutes until it becomes uniform. Incorporate the extracts of mahua, adulsa, cinnamon and clove. Continue the stirring until it becomes viscous.

The final herbal syrup was prepared and subjected for evaluation.

Herbal syrup was prepared and pH, stability, density and microbial assay were done to check the effectiveness of the herbal syrup.[16]

Table 02: Preparation of Anti-Tussive Herbal Syrup For 50ml.

	Ingredients	Batch 1	Batch 2	Batch 3	Batch 4	Final Batch 5
1	Mahua	1ml	1ml	1ml	1ml	1ml
2	Adulsa	6ml	8ml	7ml	5ml	5ml
3	Cinnamon	1.4	1.1	2.5	2.1	1.25ml
4	Clove	2.6	2.9	1.5	2.3	2.75ml
5	Honey	30ml	30ml	30ml	30ml	30ml
6	Purified water	10ml	10ml	10ml	10ml	10ml

Evaluation Parameters

Figure 9: Herbal Syrup Formulation.

Formulation studies

Organoleptic Character

Colour: Colour examination is done by observing the syrup directly with our naked eye Odour: Smell of final syrup was smelled individually then the Odour can be detected Taste: A pinch of final syrup was taken on taste bud of tongue to detect the taste.[17]

Phytochemical test

Phytochemical testing is performed on herbal syrups to identify and quantify bioactive compounds, such as alkaloids, flavonoids, and tannins, which contribute to the therapeutic properties of the formulation. These tests are essential for ensuring the consistency, quality, and safety of the product, as well as validating its claimed medicinal benefits.[18]

Table 3: Phytochemical tests for mahua.

Name of Test	Procedure	Observation	Result
Salkowski Test	Sample + 2 mL chloroform + 2 mL conc. H2SO4; shake	Red colour appears	Steroid Present
Borntrager's Test	Sample + 2 mL Fecl3 solution	Reddish pink colour appears	Glycoside Present

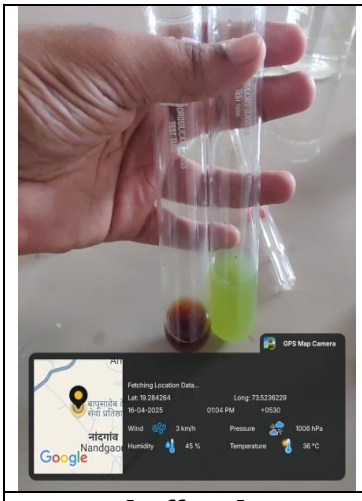
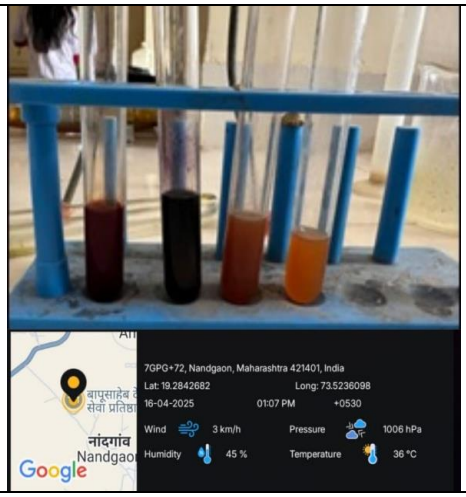
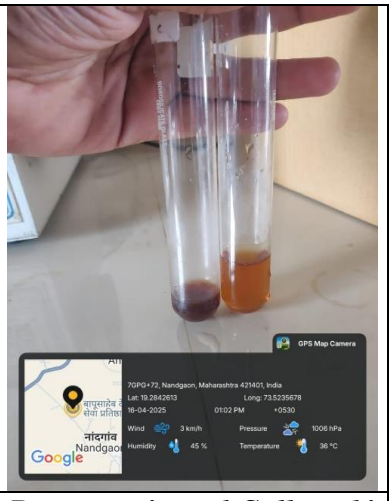
Table 4: Phytochemical tests for Adulsa.

Name of Test	Procedure	Observation	Result
Dragendroff's test	Sample + 2 mL Dragondroff's reagent	Reddish brown ppt appears	Alkaloids Present
Hager's test	Sample + hager's reagent	Orange/yellow ppt appears	Alkaloids Present

Table 5: Phytochemical tests for Clove and cinnamon.

Name of Test	Procedure	Observation	Result
Test for carboxylic acid	Sample + dilute $NaHCO_3$ solution	Strong effervescence	Carboxylic acid present
Test for anilide	Sample + ethanol + conc. HCl, then add $NaNO_2$ solution	Orange red dye	Anilido group present
Test for phenol (Liberman test)	Sample + $NaNO_2$ + 1 mL H_2SO_4 + NaOH	Red coloration which turns to bluish greenish coloration	Phenol present
Test for aldehyde (Schiff's test)	Sample + Schiff's reagent	Pink color slowly develops	Aromatic aldehyde present

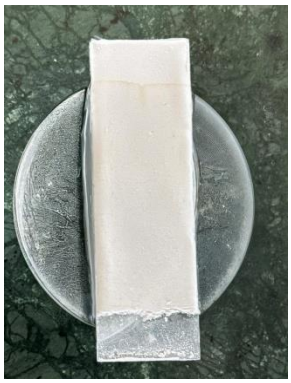
Table 6: Results Phytochemical tests.

		
Dragendorff and Hagers test.	***Tests for cinnamon extract.***	***Bontrager's and Salkowski test.***

TLC(Thin Layer Chromatography): TLC was performed to analyse and confirm the presence of key phytoconstituents in the herbal syrup by comparing the Rf values of the sample spots with those of standard markers.[19]

Table 6: Determination of Thin layer chromatography.

Sr no.	Ingredients	Stationary Phase	Mobile Phase	Observed RF Value	Standard RF Value
1	Mahua	Silica Gel g	Chloroform: Methanol	0.84	0.94
2	Adulsa	Silica Gel g	Chloroform : Methanol : Water	0.55	0.63
3	Clove	Silica Gel g	Toluene : Ethyl Acetate	0.61	0.66
4	Cinnamon	Silica Gel g	Toluene : Ethyl Acetate	0.56	0.66

			
Mahua	Adulsa	Clove	Cinnamon

pH: The pH determination was done by using glass electrode

Buffer Preparation: Prepare 30 mL of each buffer by mixing appropriate volumes of stock solutions to achieve the desired pH.

1. Equilibration: Let the solutions stand for 15 minutes to reach equilibrium.
2. pH Measurement: Measure the pH using a calibrated pH meter with a glass electrode.

Solutions

0.2 M Acetic Acid: Dilute 1.2 mL of glacial acetic acid (MW: 60.605, density: 1.050 g/mL) to 100 mL with distilled water.

Buffer Solution: Dissolve 10.21 g of potassium hydrogen phthalate in CO_2-free water and dilute to 1000 mL.

The pH ranges between 4.50-5 of all batches respectively.[20]

Figure 10. pH meter.

Viscosity

Procedure for Determining Viscosity

1. Clean the Ostwald viscometer thoroughly using warm chromic acid; if needed, use an organic solvent such as acetone to remove any residual substances.

2. Secure the viscometer in an upright position using a proper stand.
3. Fill the viscometer with distilled water until it reaches the G mark.
4. Measure and record the time (in seconds) it takes for the water to flow from point A to point B.
5. Repeat the measurement process at least three times to ensure consistent and accurate results.
6. Rinse the viscometer with the test liquid, then fill it up to the A mark and note the time it takes for the liquid to reach point B.
7. Determine the density of the test liquid using the method described in the density determination experiment.[21]

Formula for viscosity

Density of test liquid×Time required to flow test liquid ×Viscosity of water

Density of water×Time required to flow water

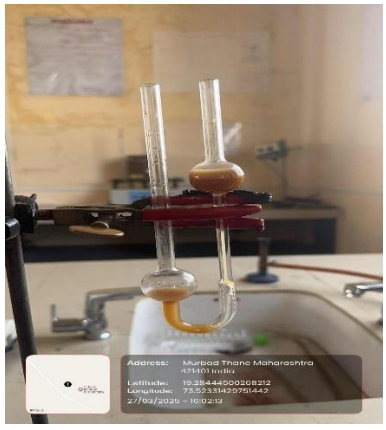


Figure 11: Ostwald Viscometer.

Procedure for Determining Density

1. Thoroughly clean the specific gravity bottle using chromic acid or nitric acid to eliminate any residues.
2. Rinse the bottle two to three times with distilled water to ensure proper cleaning.
3. If needed, use an organic solvent such as acetone to rinse the bottle, then dry it completely.
4. Weigh the empty, dry bottle along with its capillary stopper and record this as w_1.
5. Fill the bottle with the test liquid, insert the stopper, and carefully remove any excess liquid from the outer surface using a tissue.
6. Weigh the filled bottle using an analytical balance and note this as w_2.

7. Calculate the mass of the liquid by subtracting the empty bottle weight from the filled bottle weight ($w_3 = w_2 - w_1$).[22]

$$\text{Density} = \frac{\text{Weight of liquid } (w_3)}{\text{Volume of the bottle}}$$

Determining Specific Gravity

1. Clean the specific gravity bottle thoroughly using chromic acid or nitric acid to remove any impurities.
2. Rinse the bottle at least two to three times with purified water to ensure it's free from contaminants.
3. If necessary, rinse the bottle with an organic solvent like acetone and then dry it completely.
4. Weigh the empty, dry bottle along with its capillary stopper and record this as $\mathbf{w_1}$.
5. Fill the bottle with distilled water, place the stopper, and wipe away any excess water from the outside of the bottle using tissue paper. Record this weight as $\mathbf{w_2}$.
6. Weigh the bottle with distilled water and stopper using an analytical balance. Note this as $\mathbf{w_2}$.
7. For the test liquid, empty and dry the bottle, and then repeat steps 4 to 6 by replacing the water with the test liquid.
8. Weigh the bottle with the stopper and the test liquid and record this weight as $\mathbf{w_3}$.

Formula for specific gravity: Specific gravity of liquid under test (syrup) = weight of liquid under test /weight of water = w5/w4.

Microbial assay

Agar with peptone, NaCl, and beef extract, autoclaved, and poured into sterile Petri plates. *S. aureus* was inoculated in nutrient broth and adjusted to a 0.5 McFarland standard. The suspension was spread evenly on the agar surface using a sterile cotton swab. Four 6 mm wells were punched, and 100 µL of herbal syrup, marketed Adulsa syrup, and optionally, different dilutions or a blank were added to the wells. The plates were incubated at 37°C for 24 hours, and the zone of inhibition around each well was measured to evaluate antimicrobial activity.[23]

RESULT

Sr no.	Evaluation Parameters	Batch 1	Batch 2	Batch3	Batch4	Batch 5
1	Colour	Pale Yellow	Pale Yellow	Pale Yellow	Pale Yellow	Pale Yellow
2	Odour	Aromatic	Aromatic	Aromatic	Aromatic	Aromatic
3	Taste	Pleasantly sweet	Bitter	Bitter-spicy	Well balanced	Sweet & aromatic
4	pH	4.68	4.9	4.7	4.53	4.78
5	Viscosity	35.5	37.2	36	37	37.5
6	Density	1.328	1.288	1.211	1.279	1.247
7	Specific Gravity	1.328	1.288	1.211	1.279	1.247

Table 13: Microbial Assay.

Well No.	Sample	Zone of Inhibition	Antimicrobial Activity
1	Herbal syrup	8mm	Present
2	Herbal syrup	7mm	Present
3	Herbal syrup	8mm	Present
4	Marketed Adulsa syrup	10mm	Present
5	Marketed Adulsa syrup	8mm	Present
6	Marketed Adulsa syrup	8mm	Present

Standard – Ayusas aduksa cough syrup – (S1,S2,S2)

Formulation sample – (F1,F2,F3)

As further our sample show equivalent anti-microbial activity as marketed syrup.

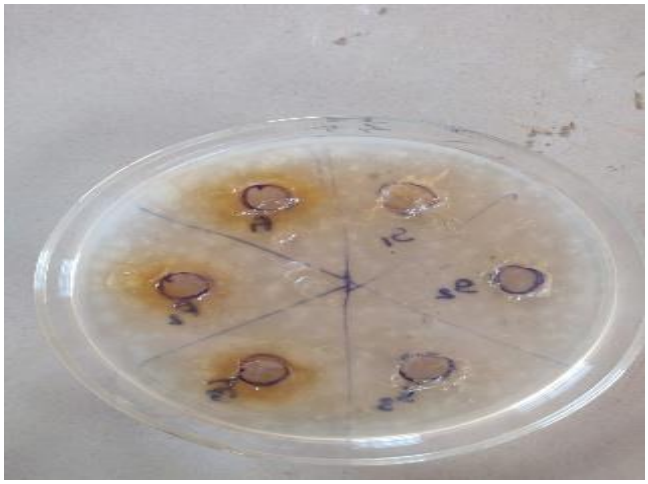


Figure 12: Microbial Assay.

DISCUSSION

Formulation of Herbal Syrup: Herbal formulation was prepared by using mahua adulsa, clove, cinnamon and honey. It involves base preparation to incorporation of extract to ensure the efficacy.

Chemical Evaluation: The chemical evaluation was performed on herbs with preliminary phytochemical test.

Stability Testing: Stability testing was performed for the timeline of more than one month and pH determination, Viscosity and microbial assay was performed.

CONCLUSION

The herbal syrup formulated using Mahua, Adulsa, Clove, Cinnamon, and Honey was successfully prepared using the decoction method. The syrup showed good physical characteristics, acceptable taste, and remained stable over the evaluation period. The combination of herbal ingredients provided potential antitussive, antimicrobial, and soothing properties. No signs of microbial contamination or physical instability were observed during one month of storage. Thus, the formulation is effective, safe, and suitable for use as a natural cough remedy.

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