

Formulation and Evaluation of Polyherbal Cough Syrup using *Madhuca Longifolia*

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Abstract: *The formulation and evaluation of polyherbal cough syrup represent a significant stride in addressing respiratory health. This study focuses on combining various medicinal herbs to create an effective cough remedy. The formulation process involves meticulous selection and blending of herbs known for their therapeutic properties, aiming to enhance the syrup's efficacy in relieving cough symptoms. The evaluation phase encompasses a comprehensive analysis of the polyherbal syrup, including physicochemical parameters, stability, and sensory attributes.*

The polyherbal cough syrup is crafted with precision, considering the synergistic effects of individual herbs to maximize therapeutic benefits. Notably, the inclusion of diverse herbal components seeks to provide a holistic approach to cough relief, targeting various aspects of respiratory discomfort. The study employs standardized methods to assess the syrup's viscosity, pH, microbial stability, and overall quality.

Through systematic evaluation, the research aims to validate the safety, efficacy, and acceptability of the polyherbal cough syrup. The findings contribute valuable insights into the development of a well-tolerated and potent remedy for cough management. This research aligns with the increasing interest in herbal formulations, emphasizing a natural and holistic approach to healthcare. The formulation and evaluation of this polyherbal cough syrup offer a promising avenue for advancing herbal medicine in the context of respiratory wellness.

Keywords: *Madhuca Longifolia, Polyherbal, Synergistic effect, Holistic approach*

I. INTRODUCTION

Coughing is a common problem that affects everyone. Coughing is a distinctive reflex expulsive resistance system of the body used to clear excessive discharges or mucous, as well as breathed-in aggravations, toxins, or foreign substances in the respiratory tract. Coughing protects the respiratory system by clearing or cleaning it, either deliberately or unintentionally. Coughing should not be interrupted as long as it aids in the removal of infectious material from the airway via mucus production. Cough is typically associated with a normal cold, but it can also be the first sign of a serious condition such as pulmonary hypertension, pneumonia, tuberculosis, or asthma. It is critical to remember this. It can be improperly triggered in a variety of conditions, including respiratory tract inflammation and neoplasia. In certain circumstances, the cough has pathological characteristics, necessitating the administration of cough suppressants. Anti-tussive medicines are mostly used to treat dry, unpleasant coughs.^[1,2]

Mechanism of Cough:

Coughing helps to empty the airways of significant volumes of inhaled material, mucus from excessive secretions or inadequate mucociliary clearance, and abnormal substances like edema fluid or pus. Each cough triggers a complicated reflex arc. The cough reflex is made up of five parts: cough receptors, an afferent nerve (the vagus nerve), the cough centre (a medulla area), motor (efferent) nerves (recurrent laryngeal nerve, phrenic nerve, and spinal nerves), and effector organs (the diaphragm, chest, and belly wall muscles). Cough receptors are found throughout the laryngo-tracheo-bronchial tree, with the most concentrated in the larynx. They're also found in the nose, paranasal sinuses, diaphragm, pleura, stomach, and pericardium. Three types of nerve fibres make up the sensory (afferent) pathway that leads to cough.^[3]

- Myelinated irritant fibres
- Unmyelinated C fibres
- Slow adapting stretch receptors

Mechanism of Cough is as follow:

- Coughing is started by stimulation of sensory nerves in the lining of the respiratory passages - the tubes used to breathe.
- Diaphragm and external inter-costal muscles contracts, increase the volume of the lungs and makes the pressure of air within the lungs lower than atmospheric pressure. Air rushes into the lungs in order to equalize the pressure.
- The glottis closes (muscles innervated by repetitive laryngeal nerve) to anticipate air getting away while the stomach unwinds and expiratory muscles contract.
- This diminishes the volume of the lungs, consequently expanding weight.
- The weight of air inside the lungs is currently more noteworthy than barometrical weight thus air is endeavouring to get away. Thus, glottis opens and release air at over 100 mph.^[4]

Herbal Treatment for Cough:

Herbal treatments for cough have been used for centuries in various traditional medicine systems due to their soothing, expectorant, and antimicrobial properties. The most preferred treatment for cough is herbal treatment. Herbal formulations are playing major role in improvement of health care sector. The Herbal treatments are used for mild to severe health disorders including, asthma, tuberculosis, cough, pneumonia, kidney diseases, cancer, diabetes, allergies, lung cancer and viral infections. As stated, to estimate of WHO, there are 80% population even uses herbal medicines for primary health care requirements. Medicinal herbs have always been used as traditional primary healthcare agents and especially in Asian countries. Major use of herbal medicines is for health promotion and therapy for chronic, as opposed to condition which are life threatening. Most of the synthetic drug treatment used causes many side effects like vomiting, nausea, sedation, allergies, respiratory tract infections, appetite change, irritability, drowsiness, addiction and excess use can damage organs or parts of organs. In recent years, researchers are mainly focusing on herbal drugs and herbal treatments which have less or have no side effects during and after treatment.

These herbal remedies can be used alone or in combination to provide relief from cough symptoms. However, it's important to consult with a healthcare professional before using herbal treatments, especially if you have underlying health conditions or are taking medications, to avoid potential interactions or adverse effects.

Herbal Cough Syrup:

Coughing, a reflex action of the respiratory system, serves as a vital defence mechanism against various irritants and pathogens that threaten the airways. While coughing is a natural response, persistent or severe coughing can cause discomfort and disrupt daily activities. In the quest for relief, individuals often turn to cough syrups, seeking remedies that effectively alleviate symptoms without unwanted side effects.

Amidst the diverse array of cough syrups available, herbal cough syrups have emerged as a popular alternative, drawing upon centuries-old traditions of herbal medicine. These formulations harness the therapeutic properties of medicinal plants to address cough symptoms, offering a natural and holistic approach to respiratory health.

Herbal cough syrups represent a harmonious convergence of ancient healing traditions and modern scientific understanding. By harnessing the power of nature's pharmacy, these formulations offer relief from cough symptoms while minimizing the risk of adverse effects associated with synthetic medications. As interest in natural remedies continues to grow, herbal cough syrups stand poised to play a prominent role in promoting respiratory wellness and enhancing quality of life.

Ingredients and Mechanisms

Herbal cough syrups typically feature a blend of botanical extracts, each selected for its specific medicinal properties. Common ingredients may include licorice root, thyme, ginger, marshmallow root, and eucalyptus, among others. These herbs contribute a diverse array of bioactive compounds, including expectorants, demulcents, antimicrobials, and anti-inflammatories, which collectively target the underlying mechanisms of coughing.

Licorice root, for example, contains glycyrrhizin, which exhibits expectorant and anti-inflammatory properties, aiding in the expulsion of mucus and soothing throat irritation. Thyme boasts antimicrobial compounds such as thymol, which combat respiratory infections and promote respiratory health. Ginger offers anti-inflammatory benefits, while eucalyptus provides decongestant and expectorant effects, facilitating easier breathing.

Traditional Wisdom Meets Modern Science

The efficacy of herbal cough syrups is rooted in both traditional wisdom and modern scientific inquiry. While traditional medicine systems have long recognized the healing potential of medicinal plants for respiratory ailments, contemporary research continues to elucidate the pharmacological mechanisms underlying their therapeutic effects.

Studies have documented the antimicrobial, anti-inflammatory, and expectorant properties of individual herbal constituents, validating their traditional uses in treating cough and respiratory conditions. Moreover, clinical trials evaluating the effectiveness of herbal cough syrups have yielded promising results, affirming their role as safe and effective alternatives to conventional cough remedies.

Benefits of Herbal Cough Syrup:

Gentle Relief: Herbal cough syrups are generally milder and less likely to cause side effects compared to their medicated counterparts. This makes them suitable for children and individuals with sensitivity to pharmaceutical ingredients.

Soothing Properties: Many herbal ingredients have natural soothing properties, making herbal cough syrups ideal for coughs associated with a sore throat or cold.

Holistic Approach: Herbal remedies align with a holistic approach to health, which appeals to those seeking a more natural and traditional solution to health issues.

II. DRUG PROFILE:

Madhuca Longifolia:

Madhuca longifolia, commonly known as Mahua or Mahua tree, is a species of tree native to the Indian subcontinent. The tree is known for its many uses, including its flowers, which have several traditional and cultural applications.



- **Appearance:** The flowers of *Madhuca longifolia* are small, fragrant, and typically pale yellow to cream in color. They grow in clusters and have a pleasant aroma.
- **Cultural Significance:** In many parts of India, especially tribal areas, the flowers of *Madhuca longifolia* hold cultural and religious importance. They are used in various rituals, festivals, and ceremonies.
- **Edible Uses:** The flowers are edible and have been traditionally used in culinary preparations. They can be eaten raw, or used in making sweets, jams, or fermented to produce an alcoholic beverage known as "mahua" or "mahua liquor".

- **Medicinal Properties:** Madhuca longifolia flowers are used in traditional Ayurvedic medicine for their medicinal properties. They are believed to have antioxidant, anti-inflammatory, and rejuvenating effects.
- **Industrial Uses:** The flowers contain a significant amount of oil, which is extracted and used in various industries. Mahua oil is used in cooking, soap-making, and as a lubricant.
- **Wildlife Importance:** The flowers attract various species of birds and insects, making them important for biodiversity and ecological balance.
- **Harvesting:** The flowers are typically harvested during the flowering season, which varies depending on the region but generally occurs during the summer months.^[6,8]

Health benefits of mahua flower:^[7]

- **Anthelmintic activity:** Ethanol and methanol extracts of the flowers of Madhuca longifolia for its possible anthelmintic activity in *Pheretimaposthuma* (Indian Earth Worm).
- **Antibacterial activity:** Aqueous extract shows more activity than methanolic extract for both bacteria. The flower has an antibacterial activity against the Escherichia coli and resist against rice pest disease.
- **Analgesic activity:** The both aqueous and alcoholic extract of flowers of Madhuca longifolia posse's analgesic effect.
- **Hepatoprotective activity:** The methanolic extract of flowers of Madhuca longifolia shows the hepato protective activity against paracetamol induced hepatotoxicity.

Honey:

Honey is a natural remedy that has been used for centuries to help alleviate cough symptoms.

- **Soothes the Throat:** Honey has a soothing effect on the throat. It coats the irritated mucous membranes, reducing the urge to cough and easing discomfort.
- **Antibacterial and Antiviral Properties:** Honey has natural antibacterial and antiviral properties, which can help fight infections that cause coughs, particularly those of the upper respiratory tract.
- **Reduces Cough Frequency and Severity:** Research suggests that honey can be as effective as over-the-counter cough suppressants in reducing cough frequency and severity, especially in children.
- **Natural Remedy:** Honey is a natural alternative to cough syrups that may contain artificial ingredients. It is generally safe and well-tolerated.

Honey can be combined with other soothing herbs like ginger, turmeric, or lemon to enhance its cough-relieving effects.

Liquorice:

Licorice root, derived from the Glycyrrhiza glabra plant, has been used for centuries in traditional medicine for its various health benefits, including its effectiveness in cough treatment.

- **Soothing Properties:** Licorice root contains compounds that have demulcent properties, meaning they form a protective layer over irritated mucous membranes in the throat, providing relief from cough and throat irritation.
- **Expectorant Effect:** Licorice root also has expectorant properties, which can help to loosen and expel mucus from the respiratory tract. This can be particularly beneficial for coughs accompanied by phlegm.
- **Anti-inflammatory:** Licorice root has anti-inflammatory properties that can help reduce inflammation in the throat and airways, thereby easing cough symptoms.
- **Antiviral and Antibacterial:** Some studies suggest that licorice root may have antiviral and antibacterial properties, which can help fight infections that cause coughs, such as colds and flu.

Licorice root can be used as an ingredient in herbal syrups for cough relief. These syrups often combine licorice with other soothing herbs like marshmallow root or slippery elm.

Adulsa:

Adulsa, also known as Adhatoda vasica or Vasaka, is a medicinal plant commonly used in traditional Ayurvedic and Unani medicine for the treatment of respiratory ailments, including coughs and bronchitis.

- **Bronchodilator:** Adulsa contains active compounds like vasicine and vasicinone, which have bronchodilator properties. This means that it can help relax and widen the airways, making it easier to breathe, especially in cases of cough associated with asthma or bronchitis.
- **Expectorant Effect:** Adulsa acts as an expectorant, which means it helps loosen and expel excess mucus from the respiratory tract. This can be beneficial in alleviating coughs that are productive (producing phlegm).
- **Anti-inflammatory Properties:** Adulsa has anti-inflammatory effects, which can help reduce inflammation in the airways and throat, providing relief from cough and associated symptoms like throat irritation.
- **Antimicrobial Activity:** Adulsa possesses antimicrobial properties that can help fight respiratory infections caused by bacteria and viruses, which are common triggers for cough.
- **Adulsa Syrup or Decoction:** Adulsa leaves can be used to prepare syrups or decoctions (herbal extracts) that are consumed orally to relieve cough symptoms.

Cinnamon:

Cinnamon is a spice derived from the inner bark of trees belonging to the Cinnamomum genus. It is widely used in culinary preparations and also holds potential health benefits, including its use in cough treatment.

- **Antibacterial and Antiviral Properties:** Cinnamon contains compounds like cinnamaldehyde that exhibit strong antibacterial and antiviral properties. This can help fight infections that contribute to coughs, such as colds and flu.
- **Anti-inflammatory Effects:** Cinnamon has anti-inflammatory properties that can help reduce inflammation in the throat and airways, providing relief from cough and irritation.
- **Soothing to Throat:** Cinnamon has a warming and soothing effect on the throat, which can help alleviate cough symptoms and throat discomfort.
- **Expectorant Action:** Cinnamon can act as an expectorant, promoting the expulsion of mucus from the respiratory tract. This can be particularly helpful for productive coughs.

Mix cinnamon powder with honey to create a natural cough syrup. Take a spoonful as needed to help calm cough and sore throat.

Tulsi:

Tulsi, also known as Holy Basil or Ocimum sanctum, is a revered herb in Ayurveda known for its medicinal properties. It is commonly used in the treatment of cough and respiratory ailments due to its antimicrobial, anti-inflammatory, and immunomodulatory effects.

- **Antimicrobial Properties:** Tulsi has strong antimicrobial properties, which can help combat infections that cause cough, such as bacterial and viral respiratory infections.
- **Anti-inflammatory Effects:** Tulsi possesses anti-inflammatory compounds that can reduce inflammation in the respiratory tract, easing cough symptoms and throat irritation.
- **Immunomodulatory Action:** Tulsi is known to enhance the immune system, which can aid in fighting off infections and speeding up recovery from cough and colds.
- **Bronchodilator Activity:** Tulsi has bronchodilator properties, which means it can help relax and widen the airways, making breathing easier and relieving cough associated with asthma or bronchitis.
- **Expectorant Effect:** Tulsi can act as an expectorant, facilitating the expulsion of mucus from the airways. This can be particularly helpful for clearing a congested chest and alleviating productive coughs.

Prepare tulsi tea by steeping fresh tulsi leaves or dried tulsi leaves in hot water. Add honey and ginger for added benefits. Drink this tea several times a day to soothe cough and respiratory discomfort.

Boil fresh tulsi leaves in water to make a decoction. Strain and drink this concoction warm to relieve cough symptoms.

Tulsi syrup or extract can be taken orally as directed to alleviate cough and respiratory congestion.

III. MATERIAL AND METHOD

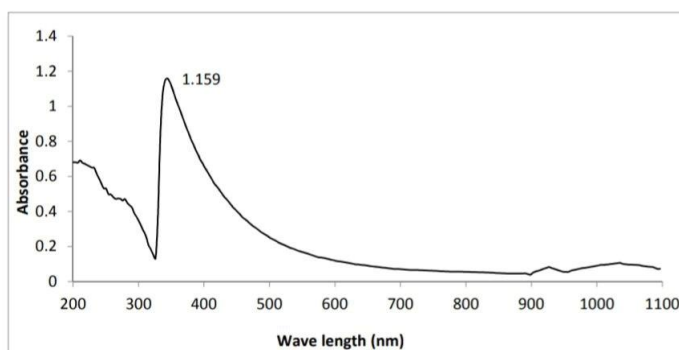
Sr. No.	Ingredient	Uses
1	Mahua Flower	Expectorant, Cure cough
2	Adulsa	Antitussive
3	Cinnamon	Expectorant, Preservative
4	Tulsi	Antitussive
5	Liquorice	Expectorant
6	Honey	Base, Viscosity Modifier
7	Menthol	Decongestant, Expectorant

Instruments	Model
UV-Visible Spectroscopy	UV-1900I
FTIR	Bruker Alpha
Ph Meter	Systonic S-902
Oswald's Viscometer	-

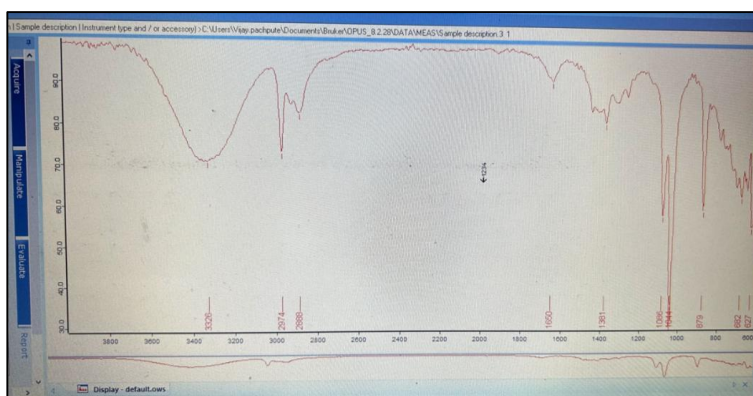
PRE-FORMULATION OF DRUG MATERIAL

UV-Visible Spectroscopy Analysis:

UV-Visible spectrum of the Methanolic Extract of Mahua Drug was taken and scanned in the range of 200-1100 nm on UV-Visible Spectrophotometer. The UV-Visible Spectrum of extract of M. Longifolia flowers showed maximum absorption (1.159) at 344 nm.^[19]



Fourier-Transform Infrared Spectroscopy Analysis:



Sr. No.	Wave Number	Functional group	Structure of functional group
1	3326	Amino grp	N-H
2	2974	Methine grp	C-H
3	2888	Methine grp	C-H
4	1650	Nitrile grp Amino grp	C=N N-H
5	1381	Halo grp (Fluorine) Nitro grp Methine grp	C-F NO ₂ C-H
6	1086	Halo grp (Fluorine) Alkane grp	C-F C-C
7	1044	Halo grp (Fluorine) Alkane grp	C-F C-C
8	682	Chlorine grp	C-Cl
9	627	Chlorine grp Bromine grp	C-Cl C-Br

Functional Groups determined through FTIR analysis

Terpenoid Test Analysis: ^[17]

We perform the **Salkowski's test** for the determination of presence of terpenoid in the Methanolic extract of *M. Longifolia*. From the test we conclude that there is presence of terpenoids in the Methanolic extract of *M. Longifolia*.

PREPARATION OF LIQUID ORAL:

Method of Preparation of Decoction:

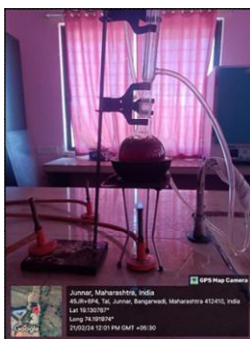
Decoction of Tulsi and Adulsa: ^[14]

The fresh green leaves weighed nearly 30-40g was taken
 ↓
 washed and cleaned properly and added in a beaker
 ↓
 soaked with 400-500ml distilled water
 ↓
 kept aside undisturbed for nearly 4-5 hours
 ↓
 then boiled it until the quantity of water remain one third of original nearly 20-25 ml
 ↓
 filtered with muslin cloth and stored well



Decoction of cinnamon and liquorice:^[15]

7 gm of each powder were weighed
↓
The drug was mixed using 500 ml of water
↓
Attach reflux condenser and material was boiled carefully by using water bath for 3 hrs
↓
Boil the total volume until it become one forth part of the previous
↓
The liquid was cooled and filtered



Method of Preparation of Maceration:^[15]

1 gm of M. Longifolia (Mahua flower) powder were weighed and mixed with 25 ml of honey in the beaker
↓
packed with aluminium foil
↓
Beaker allowed to stand at room temperature for 24 hrs
↓
After 24 hrs, the preparation filtered and was used for the final oral formulation



Preparation of Syrup:^[15]

To prepared 25 ml, 30 ml, 35 ml and 40 ml of macerated drug with honey, add the prepared decoctions of the excipients in given amount and mixed slowly with continuous stirring
↓
Herbal cough syrup was prepared
↓
Solubility was checked by observing clarity of solution



FORMULATION TABLE:

Sr. No.	Ingredients	F 1	F 2	F 3	F 4
1	Mahua	1 gm	1 gm	1 gm	1 gm
2	Adulsa	20 ml	15 ml	10 ml	5 ml
3	Cinnamon	25 ml	25 ml	25 ml	25 ml
4	Tulsi	20 ml	20 ml	20 ml	20 ml
5	Liquorice	10 ml	10 ml	10 ml	10 ml
6	Honey	25 ml	30 ml	35 ml	40 ml
7	Menthol	0.3 gm	0.3 gm	0.3 gm	0.3 gm

IV. RESULTS OF EVALUATION TESTS

Authentication of Drug:

<mailto:https://powo.science.kew.org/taxon/urn:lsid:ipni.org:names:77189991-1>

Organoleptic Tests:

Sr. No.	Parameters	F 1	F 2	F 3	F 4
1	Colour	Brownish	Brownish	Brownish	Brownish
2	Odour	Sweet	Sweet	Sweet	Sweet
3	Taste	Bitter	Bitter	Slightly Sweet	Sweet

pH Determination:

10 ml of prepared syrup taken in 100 ml volumetric flask.

Make up the volume to 100 ml with distilled water.

Sonicate for 10 minutes.

pH was measured by using digital pH meter.

Sr. No.	pH
F 1	5.7
F 2	5.5
F 3	5.8
F 4	6.2

We determined the pH of the polyherbal cough syrup, which found to be within the range of neutral pH. As the formulation is in the range of 5-6 pH (Oral administration accepts pH from 5 to 8) hence it has no irritation inside the oral cavity and hence achieve the patient compliance.

Determination of Density and Specific Gravity:

We determined the density and specific gravity of all the batches of the polyherbal cough syrup. All the batches have the different density and specific gravity which are mentioned in the table.

Sr. No.	Density (gm/ml)	Specific Gravity (g/g)
F 1	1.10	1.13
F 2	1.13	1.142
F 3	1.164	1.168
F 4	1.19	1.20



Determination of Viscosity:

We determined the viscosity of all the batches of the polyherbal cough syrup and the results are mentioned in the table.

Sr. No.	Viscosity
F 1	2.457
F 2	2.931
F 3	3.841
F 4	5.65



Determination of Microbial Activity:

The anti-microbial activity was successfully performed for F4 syrup. The antimicrobial activity was determined by measuring the diameter of zone of inhibition. The results of anti-microbial activity of Mahua Cough Syrup are mentioned in the table.



Maximum zone of inhibition was found to be 8mm against Escherichia coli. Hence it is determined that, the flowers of *M. longifolia* flowers show antimicrobial activity against Escherichia Coli.

Test Micro-organism	Zone of Inhibition (mm)
<i>Escherichia Coli</i>	8 mm

Determination of Stability:

Intended Storage Condition	Test Temp and Humidity (Period in months) as per ICH	Test Temp and Humidity (Period in months) as per WHO
Room Temperature	25 ± 2°C / 60 ± 5 % RH	25 ± 2°C / 60 ± 5 % RH 30 ± 2°C / 65 ± 5 % RH 30 ± 2°C / 75 ± 5 % RH
Refrigerated	5°C / ambient	5 ± 3°C

We determined the stability of all the batches of polyherbal cough syrup as per WHO. The stability testing was performed by keeping final formulation under variation of temperature. It is observed that polyherbal syrup was homogeneous & does not show any turbidity & there was no any change in colour, odour, taste & pH.

V. CONCLUSION

Polyherbal extract loaded Cough Syrup were successfully formulated using the main drug constituent *M. Longifolia* and other excipients like Honey, Adulsa, Tulsi, Cinnamon, Liquorice, etc. From this novel approach, it can be concluded that the dried flowers of *Madhuca Longifolia* can also be used for relieving the symptoms of cough and can be formulated in the liquid oral dosage form with the help of various excipients in accordance with their appropriate concentration.

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