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"Formulation and Evaluation of Herbal Cough Syrup with Antibacterial and Expectorant Properties"

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ABSTRACT:

Cough medications are among the most widely used over-the-counter treatments; however, recent reviews suggest limited evidence supporting their effectiveness. Coughing is a reflexive action that expels fluids and foreign particles from the respiratory tract. This review aims to compile information on traditionally used medicinal plants for cough relief in both children and adults. Coughs are classified into two types: dry (non-productive) and wet (productive with mucus). The objective of this study is to develop an herbal cough lozenge (saccharinely) using extracts of Nagarmotha, Pippali, Liquorice, Ginger, Amla, and Honey and evaluate its antibacterial activity against Staphylococcus aureus, E. coli, Salmonella sp., Pseudomonas aeruginosa, and Bacillus subtilis. Additionally, physicochemical parameters such as turbidity, colour, scent, taste, viscosity, and pH were assessed through stability testing. Furthermore, a herbal cough syrup was formulated and evaluated for key quality parameters, including viscosity, pH, colour, appearance, and scent. Clove oil, known for its expectorant properties, was incorporated to enhance therapeutic efficacy in respiratory conditions such as colds, bronchitis, cough, asthma, and upper respiratory infections. The findings of this study contribute to the development of natural, effective cough treatments with antibacterial and expectorant properties.

Keywords: Nagarmotha, Pippali, Liquorice, Ginger, Amla, and Honey etc.

Introduction:

Herbal Medicine: Formulation, Stability, and Benefits: For centuries, nature has been a vital source of therapeutic agents, with many modern drugs derived from plants based on traditional uses. Advancements in medicinal chemistry and biosynthetic technology have enhanced the development of bioactive compounds for various treatments. Public interest in herbal remedies has grown significantly, especially for managing common ailments like cough, which can result from infections, pollution, smoking, asthma, or bronchitis. Effective cough treatment requires both addressing the underlying cause and desensitizing cough pathways. Liquid dosage forms like cough syrups offer easy administration, particularly for those with difficulty swallowing solid medications. These syrups, typically high in sugar, may contain preservatives to prevent contamination. [1-3]

This study focuses on formulating and evaluating multi-herbal anti-tussive syrup using natural ingredients such as Nagarmotha (Cyperus Rotundus), Pipli (Piper Longum), Liquorice (Glycyrrhiza Glabra), Ginger (Zingiber Officinale), Amla (Indian Gooseberry), and Honey. These herbal expectorants help clear mucus from the lungs and offer a safer alternative to synthetic cough medicines. [4-7]

Stability Testing of Herbal Formulations: Stability studies assess the impact of environmental factors like temperature, light, humidity, and microbial contamination on herbal products. These tests help determine optimal storage conditions, shelf life, and quality consistency. [8-10]

Advantages of Herbal Medicine

1. Boosts immunity
2. Culturally accepted and body-compatible
3. Affordable with minimal side effects
4. Organic and widely available
5. Helps manage chronic diseases like Alzheimer's

Disadvantages of Herbal Medicine:

1. Risk of wild herb toxicity
2. Lack of regulation and dosing guidelines
3. Possible interactions with modern medicine
4. Not suitable for all health conditions. [11-13]

Material and Methods:

The following herbal medications are used to create herbal syrup with expectorant and antipyretic properties. [14-16]

Table no. 01: herbal medications are used to create herbal syrup with expectorant, and antipyretic properties:

Herbal Ingredient	Botanical Name	Family	Therapeutic Property
Pippali	*Piper Longum*	Piperaceae	Expectorant
Nagarmotha	*Cyperus Rotundus*	cyperaceae	Expectorant
Liquorice	*Glycyrrhiza Glabra*	Leguminosae	Expectorant
Ginger	*Zingiber Officinale*	Zingiberaceae	Antipyretic
Amla	*Phyllanthus Emblica*	Phyllanthaceae	Antipyretic
Honey	Apismelifera	Apidae	Sweetening agent
LemonOil	Citrus limon	Rutaceae	preservatives

Ingredients and Preparation for Formulation:

a) Nagarmotha (*Cyperus rotundus*): Dried rhizomes (20–30g) were sun-dried for 4–5 hours before use. Pippali (*Piper longum*): Dried, oval-shaped fruit (10–20g) was used.
b) Liquorice (*Glycyrrhiza glabra*): Dried, peeled/unpeeled roots (20–30g) were selected.
c) Ginger (*Zingiber officinale*): Fresh or dried rhizomes (10–20g) were used.
d) Amla (*Phyllanthus emblica*): Fresh or dried fruit (10–20g) was utilized.
e) Honey: Commercially available, pre-filtered honey (40–50 ml) was incorporated (e.g., Dabur Honey, 250 ml).
f) All ingredients were sourced from the market in dried or fresh form for formulation.

Preparation Method for Herbal Cough Syrup: [17-20]

- **Powder Preparation:** Dried herbs (Nagarmotha, Pippali, Liquorice, Ginger, and Amla) were crushed into fine powder using a mortar and pestle. Each herb was weighed separately and stored.
- **Maceration Extraction:** Each powdered herb was soaked in 410–500 ml of distilled water (with ~5% alcohol) for 17–24 hours. The ratio of water to drug was maintained at 12:1 or 14:1.
- **Herbal Cough Syrup Preparation:** Herbs were boiled in water until one-third of the volume remained, then strained. Syrup solutions of 40%, 50%, and 60% w/v were prepared. The aqueous extract was filtered using muslin cloth and filter paper. Sugar solution was added gradually with continuous stirring. Volume was adjusted to 100 ml. Preservative and flavouring agents were added before testing.
- **Final Syrup Formulation:** 500 ml of water was mixed with herbs and boiled. The extract was cooled, filtered, and further heated until reduced to one-fourth of the original volume. The final filtrate was used to create the herbal syrup.

Sr. no	Ingredient	Quality(In ml)
1.	Nagarmotha	08ml
2.	Pippali	08ml
3.	Liquorice	08ml
4.	Ginger	08ml
5.	Amla	4ml
6.	Honey	9ml
7.	Lemon oil	5ml

Table no. 02

Sr. no	Ingredient	Quality(In ml)
1.	Nagarmotha	08ml
2.	Pippali	07ml
3.	Liquorice	09ml
4.	Ginger	09ml
5.	Amla	4.5ml
6.	Honey	4.5ml
7.	Lemon oil	3.5ml
8.	Alcohol	4.5ml

Table no. 03

Sr. no	Ingredient	Quality(In ml)
1.	Nagarmotha	14ml
2.	Pippali	14ml
3.	Liquorice	16ml
4.	Ginger	15ml
5.	Amla	15ml
6.	Honey	20ml
7.	Lemon oil	06ml

Table no. 04

Table no. 02,03, and 04: Formula for Herbal Cough Syrup Preparation

Preformulation Study of Herbal Syrup: [20-22]

1. Moisture Content: 2g sample was heated at 100°C for 1 hour, cooled, and reweighed to determine moisture content.
2. Ethanol Extractive Value: 5g air-dried drug was soaked in 100ml ethanol for 24 hours with frequent shaking, and then filtered. 25ml filtrate was evaporated and dried at 105°C for weight determination.
3. Water Extractive Value: 5g drug was soaked in 100ml water with chloroform, shaken for 6 hours, and left for 18 hours. 25ml filtrate was evaporated, dried at 105°C, and weighed.
4. Solubility Testing: 2g drug powder was tested for solubility in acetone, ethanol, chloroform, and distilled water.
5. Thin Layer Chromatography (TLC): TLC plates were prepared with silica gel, dried, and developed using ethanol as the mobile phase. Samples were spotted and RF value calculated:

RF = Distance travelled by component / Distance travelled by solvent

6. Total Ash Value: 2g sample was heated until fully ashed and weighed to calculate ash content.

7. UV Spectroscopy: Ginger extract calibration curve was recorded at 281.40nm in methanol. Stock solution of 100mg extract in 100ml methanol was diluted and analyzed.

Evaluation of Herbal Syrup: [23-25]

1. Physical Examination:

a) Color: Observed against a white background.
b) Odour: Smelled to assess fragrance.
c) Taste: Small sample tested for flavour.

2. pH Determination: pH meter was calibrated using buffer solutions (pH 4 & 7), then used to measure syrup pH.

3. Density Measurement: Syrup weight was measured using a specific gravity bottle.

Formula: Density = Weight of syrup (g) / Volume of syrup (ml)

4. Viscosity Testing: Ostwald viscometer was used to measure flow time for water and syrup.

Formula: Viscosity = (Density of syrup × Flow time of syrup) / (Density of water × Flow time of water) × 100

5. Specific Gravity Measurement: A specific gravity bottle was weighed empty, with water, and with syrup.

Formula: Specific Gravity = Weight of syrup / Weight of water

6. Stability Testing: Syrup samples were stored at 4°C, 16°C, and 47°C and observed for changes in color, odour, taste, and turbidity at 24, 48, and 72 hours intervals.

Result and Discussion:

Table no 05: Preformulation study result of herbal cough syrup

Component/ Ingredients	Nagarmotha	Pippali	Liquorice	Ginger	Amla
Moisture content (%)	1.5%	1.5%	4.5%	1%	11%
Water extractive value (%)	20.16%	15.96%	4.04%	4.08%	44.36%
Ethanolic extractive value (%)	20.72%	16%	56.92%	23.06%	4.2%

The moisture content of Nagarmotha and Pippali was found to be 1.5%, while Liquorice had a higher moisture content of 4.5%. Ginger exhibited the lowest moisture content at 1%, whereas Amla had the highest at 11%. The water extractive values varied among the ingredients, with Nagarmotha showing 20.16%, Pippali 15.96%, Liquorice 4.04%, Ginger 4.08%, and Amla displaying the highest value of 44.36%. In terms of ethanolic extractive values, Nagarmotha recorded 20.72%, Pippali 16%, Liquorice had the highest at 56.92%, Ginger showed 23.06%, and Amla had the lowest value at 4.2%.

Table no. 06: Determination of Rf value TLC:

Sample	Distance travelled by sample	Distance travelled by solvent	Rf value
Powder	3.5	6.3	0.55

The Rf value for the powdered sample was determined using Thin Layer Chromatography (TLC). The sample travelled a distance of 3.5 cm, while the solvent front travelled 6.3 cm, resulting in an Rf value of 0.55.

Table no. 07: Determination of solubility of sample:

Sr. no	Solvent	Solubility
1	Water	Insoluble
2	Ethanol	Soluble

3	Methanol	Soluble
4	Chloroform	Soluble
5	Acetone	Insoluble

The solubility of the sample was tested in different solvents. The results showed that the sample was insoluble in water and acetone, while it was soluble in ethanol, methanol, and chloroform.

Result of Determination of Specific Gravity of Syrup Solution:

a) Weight of empty specific gravity bottle (W1) = 13.58g
b) Weight of specific gravity bottle + Distilled water (W2) = 23.20g
c) Weight of specific gravity bottle + Syrup solution (W3) = 21.85g

Calculation:

a) Mass of syrup solution = W3 – W1 = 21.85 – 13.58 = 8.27g
b) Mass of distilled water = W2 – W1 = 23.20 – 13.58 = 9.62g
c) Specific gravity of syrup solution = Mass of syrup solution / Mass of equal volume of water
= 8.27 / 9.62
= 0.859

Result of Determination of Density of Syrup Solution:

a) Density of water at room temperature (P1) = 0.997 g/ml (Standard value)
b) Specific gravity of syrup solution = 0.859
c) Density of syrup solution (P2) = Specific gravity × Density of distilled water
= 0.859 × 0.997
= 0.856 g/ml

Result of Determination of Viscosity of Syrup Solution:

Viscosity of liquid (N2) = (P2 × T2) / (P1 × T1) × N1

P1 = Density of water (0.997 g/ml)

P2 = Density of syrup solution (0.856 g/ml)

N1 = Viscosity of water (0.997 cp)

T1 = Mean flow time of water (25.14 sec)

T2 = Mean flow time of syrup solution (95.3 sec)

Calculation:

N2 = (0.856 × 95.3) / (0.997 × 25.14) × 0.997
= (81.56) / (25.07) × 0.997
= 3.25 × 0.997
= 1.55 cp

Thus, the viscosity of the syrup solution at room temperature is 1.55 cp.

Table no. 08: Result of the viscosity of the syrup solution:

Liquid Sample	**Time of flow (sec)**			**Mean time (t) (sec)**	**Density (p) g/ml**	**Viscosity (n) cp**
	1	2	3			
Distilled water	25.14	25.16	25.12	25.14	0.997g/ml	0.8937 cp
Syrup solution	94	96	96	95.3	0.85642g/ml	1.55 cp

The viscosity of the syrup solution was determined using the Ostwald viscometer. The mean flow time for distilled water was 25.14 sec, with a density of 0.997 g/ml and a viscosity of 0.8937 cp. In comparison, the mean flow time for the syrup solution was 95.3 sec, with a density of 0.85642 g/ml and a viscosity of 1.55 cp. This indicates that the syrup solution has a higher viscosity than distilled water.

Table no. 09: Result of four evaluation parameter:

Sr. no	**Parameter**	**F1**	**F2**	**F3**	**F4**
1.	**Density**	0.85642g/ml	0.98603g/ml	0.97008g/ml	0.441679g/ml
2.	**Specific gravity**	0.859	0.989	0.973	0.443
3.	**Viscosity**	1.55 cp	3.73 cp	3.71 cp	2.05 cp
	pH determination				

	a) pH paper	Neutral	Neutral	Neutral	Neutral
	b) pH meter	6.34	6.46	6.88	6.08
5.	**Organoleptic character**				
	a) Color	Brownish red	Brownish red	Brownish red	Brownish red
	b) Odour	Alcoholic	Alcoholic	Alcoholic	Aromatic
	c) Taste	Sweet	Sweet	Sweet	Sweet
	d) Appearance	Clear	Clear	Clear	Clear

The evaluation of different formulations (F1, F2, F3, and F4) of the syrup solution yielded the following results:
Density varied among the formulations, with F1 at 0.85642 g/ml, F2 at 0.98603 g/ml, F3 at 0.97008 g/ml, and F4 at 0.441679 g/ml.
Specific gravity values were 0.859 (F1), 0.989 (F2), 0.973 (F3), and 0.443 (F4).
Viscosity was found to be 1.55 cp (F1), 3.73 cp (F2), 3.71 cp (F3), and 2.05 cp (F4).
pH determination: All formulations showed neutral pH using pH paper, while pH meter readings were 6.34 (F1), 6.46 (F2), 6.88 (F3), and 6.08 (F4).
Organoleptic characteristics: Color: All formulations exhibited a brownish-red color. Odor: F1, F2, and F3 had an alcoholic odor, while F4 had an aromatic odor. Taste: All formulations were sweet. Appearance: All formulations were clear in nature. These results indicate that all formulations maintained consistent organoleptic properties, while their physicochemical properties varied slightly.

Stability Study Results:

The stability of the herbal cough syrup was evaluated by storing the samples at 4°C, 16°C, and 47°C and assessing changes in color, odor, taste, and turbidity at intervals of 24, 48, and 72 hours.
At 4°C: No significant changes were observed in color, odor, taste, or turbidity throughout the study period, indicating good stability at low temperatures.
At 16°C: The syrup maintained its organoleptic properties with no noticeable variations, confirming its stability under moderate temperature conditions.
At 47°C: Minor changes in color and turbidity were noted after 48 hours, with a slight increase in turbidity at 72 hours, suggesting a potential impact of higher temperatures on syrup stability.

Conclusion:

Based on readily available standard data, this study aimed to establish key physical and chemical criteria essential for the identification of crude pharmaceuticals. The physicochemical evaluation of the formulated herbal cough syrups demonstrated desirable characteristics, including appropriate pH, viscosity, density, specific gravity, color, odor, and taste. The formulations exhibited consistent organoleptic properties, while minor variations were observed in their physicochemical parameters. Given the low risk of adverse effects, herbal formulations continue to be in high demand, reinforcing their potential as safe and effective therapeutic alternatives.

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Ethical Approval:
This review article does not content of any use of animal model.

Conflict of Interest:
Authors declared that no conflict of interest for review of article.

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