



Formulation and Evaluation of Polyherbal Gel Containing Fruits Extract of *Terminalia Chebula* and *Phyllanthus Emblica* for Treatment of Acne

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Abstract



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Acne vulgaris is a common, chronic inflammatory condition that affects the pilosebaceous units. Conventional treatments often pose side effects and resistance issues, prompting interest in safer, plant-based alternatives. To develop and evaluate a polyherbal anti-acne gel incorporating hydroalcoholic extracts of *Terminalia chebula* and *Phyllanthus emblica*, targeting the antimicrobial and anti-inflammatory pathways associated with acne. Hydroalcoholic extracts of the selected plants were prepared and subjected to phytochemical screening and quantification of total phenolic and flavonoid contents. A series of six gel formulations with varying Carbopol 940 concentrations were prepared and evaluated for pH, viscosity, spreadability, extrudability, drug content, and antimicrobial activity against *Propionibacterium acnes*. The optimized formulation (PHG3) exhibited ideal physicochemical properties including suitable pH (6.8), high drug content (92.5%), good spreadability and viscosity, and the highest antimicrobial activity with a 22 mm inhibition zone against *P. acnes*. The gel remained stable under accelerated storage conditions. The formulated polyherbal gel demonstrated significant potential as a natural, effective, and stable alternative for acne treatment, offering both therapeutic efficacy and favourable topical characteristics.

Keywords: Polyherbal gel, *Terminalia chebula*, *Phyllanthus emblica*, acne vulgaris, antimicrobial, herbal formulation

1. INTRODUCTION

Herbal medicines have been widely used for thousands of years in both developing and developed countries due to their natural origin, cultural acceptance, minimal side effects, and dissatisfaction with synthetic drugs^{1,2}. These medicines, made from medicinal plants, minerals, and organic matter, offer eco-friendly and renewable therapeutic options that benefit both health and economy. Around 80% of the world's population, especially in developing regions^{4, 5} rely on herbal remedies for primary healthcare. Herbal medicines are known for treating age-related disorders like memory loss, osteoporosis, diabetes, and immune or liver dysfunctions—many of which lack curative treatment in modern medicine. Their active constituents, being part of plant physiology, are believed to be more compatible with the human body. With the rise of chemical analysis in the 19th century, scientists began isolating active ingredients from plants, leading to a temporary decline in herbal medicine^{6, 7, 8}. However, medicinal plants remain crucial for drug discovery and formulation, attracting global scientific interest. Acne is a prevalent skin condition affecting both males and females, often causing psychological effects such as anxiety, depression, and social withdrawal. It arises due to increased sebum

production, hypercornification of sebaceous ducts, and bacterial colonization by *Propionibacterium acnes*, and inflammation. Mild acne involves comedone formation due to blocked follicles, while severe cases lead to dermal inflammation due to follicular rupture^{9, 10}. Despite the benefits of herbal drugs, challenges persist, including managing toxicity, communicating uncertainties, limited pharmacological data, poor standardization, risk of adulteration, herb-drug interactions, and difficulties in conducting clinical trials. Topical gel formulations have emerged as effective means of delivering drugs directly to the skin, bypassing systemic routes and minimizing side effects. Gels can serve various purposes like restoring skin barrier, delivering local anesthetics or anti-inflammatory agents, protecting against UV radiation, and even systemic drug delivery through transdermal systems. Defined by the USP as semisolid systems with dispersed small inorganic particles or large organic molecules, gels offer structural integrity through a three-dimensional network^{11, 12}. Gels are classified based on the nature of the colloidal phase (inorganic or organic) and the solvent used (aqueous or non-aqueous). Common gel-forming agents include natural polymers like gelatin, agar, alginates, xanthan gum, and tragacanth; semisynthetic cellulose derivatives like carboxymethyl

cellulose and hydroxypropyl cellulose; synthetic polymers such as carbomers (Carbopol 934, 940), poloxamer, polyvinyl alcohol; and inorganic substances like aluminum hydroxide and bentonite. These components are essential for forming stable, effective, and skin-compatible gels, particularly for the treatment of acne and other dermatological conditions using herbal medicines^{15, 16, 17, 18}

2. METHODS

1. Collection of Plant Material

Fruits of *Terminalia chebula* and *Phyllanthus emblica* were procured from local market and authenticated by a Pharmacognosist. Samples of the same were deposited at the department.

2. Extraction of plant material

Dried powdered the fruits were extracted with hydro-alcoholic solvent using maceration process for 48 hrs., filtered and dried using a vacuum evaporator at 40°C. Prepared extracts were stored in cool and dry place in a air-tight container.³³

3. Method of preparation

Measured quantities of methyl paraben, glycerin, polyethylene glycol, and hydroalcoholic extract of fruits of *Terminalia chebula* and *Phyllanthus emblica* were dissolved in about 35 ml of water in a beaker. They were stirred at high-speed using a mechanical stirrer (or sonicator). Then Carbopol 940 was added slowly to the beaker containing the above liquid while stirring. Neutralized the solution by slowly adding triethanolamine solution with constant stirring until the gel is formed.³⁴

Table 1: Formulation table

Ingredients (%)	PHG1	PHG2	PHG3	PHG4	PHG5	PHG6
<i>Terminalia chebula</i> extract	1gm	1gm	1gm	1gm	1gm	1gm
<i>Phyllanthus emblica</i> extract	1gm	1gm	1gm	1gm	1gm	1gm
Carbopol 940	0.5mg	0.75mg	1.0 gm	1.25 gm	1.5 gm	2.0 gm
Polyethylene Glycol	0.2ml	0.2ml	0.2ml	0.2ml	0.2ml	0.2ml
Methyl Paraben	0.08mg	0.08mg	0.08mg	0.08mg	0.08mg	0.08mg
Triethanolamine	1.0ml	1.0ml	1.0ml	1.0ml	1.0ml	1.0ml
Distilled Water (q.s)	100ml	100ml	100ml	100ml	100ml	100ml

4. Total phenolic content estimation

The total phenolic content of the extract was estimated using a modified Folin-Ciocalteu method. For the preparation of the standard, 10 mg of gallic acid was accurately weighed and dissolved in 10 mL of methanol to prepare a stock solution. From this, various aliquots in the range of 5–25 µg/mL were prepared using methanol as a diluent. To prepare the test extract, 10 mg of the dried extract was dissolved in 10 mL of methanol and then filtered to obtain a clear solution. From this filtered solution, 2 mL (equivalent to 1 mg/mL) was used for the phenolic estimation. In the assay procedure, 2 mL of either the standard or the extract solution was mixed with 1 mL of Folin-Ciocalteu reagent, which had been previously diluted in a 1:10 ratio with distilled water. Subsequently, 1 mL of sodium carbonate solution (7.5 g/L) was added to the mixture. The solution was vortexed for 15 seconds to ensure thorough mixing and then allowed to stand at room temperature for 15 minutes to allow for color development. The absorbance of the resulting blue-colored solution was measured at 765 nm using a UV-visible spectrophotometer. The total phenolic content was calculated using the calibration curve derived from the gallic acid standard, and results were expressed as gallic acid equivalents (GAE).^{35, 36}

5. Total flavonoid content estimation

The total flavonoid content of the extract was determined using the aluminum chloride colorimetric method. For the preparation of the standard, 10 mg of quercetin was accurately weighed and dissolved in 10 mL of methanol to obtain a stock solution. From this, various working concentrations ranging from 5 to 25 µg/mL were prepared in methanol. The extract was prepared by dissolving 10 mg of the dried sample in 10 mL of methanol, followed by filtration to obtain a clear solution. A 3 mL portion of this solution, corresponding to a concentration of 1 mg/mL, was used for the estimation. In the assay procedure, 1 mL of 2% aluminum chloride (AlCl₃) in methanol was added to 3 mL of either the standard or the extract solution. The mixture was allowed to stand undisturbed for 15 minutes at room temperature to allow for complex formation, resulting in a yellow coloration. The absorbance of the resulting solution was measured at 420 nm using a UV-visible spectrophotometer. The total flavonoid content was calculated from the standard calibration curve of quercetin and expressed as quercetin equivalents (QE).

^{37, 38}

6. Evaluation of polyherbal gel

1. Appearance and consistency

The physical appearance was visually checked for the appearance and consistency of Polyherbal gel formulations and observations were stated in terms of colour, clogging, homogeneity and texture.³⁹

2. Washability

Formulations were applied on the skin and then ease and extent of washing with water were checked manually and observations may be like stated.⁴⁰

3. Extrudability determination of formulations

The polyherbal gel formulations were filled into collapsible metal tubes or aluminium collapsible tubes. The tubes were pressed to extrude the material and the extrudability of the formulation was checked.⁴¹

4. Determination of Spreadability

A special apparatus has been designed to study the spreadability of the formulations. Spreadability is expressed in terms of time in seconds taken by two slides to slip off from formulation, placed between, under the application of a certain load. Lesser the time taken for the separation of two slides, better the spreadability.⁴²

5. Viscosity

Viscosity is a measure of a fluid's resistance to flow. For a gel, viscosity tells us how thick or stiff the gel is, and how easily it can spread, pour, or be squeezed. In order to determine the viscosity of a gel, Brookfield Viscometer (Rotational Viscometer) was employed. The resistance to rotation reflected the gel's viscosity. Viscosity was record for all the formulations in centipoise, cP.⁴³

6. Determination of pH

The pH of the anti-acne gels were determined by digital pH meter. One gram of gel was dissolved in 25 ml of distilled water and the electrode was then dipped in to gel formulation until constant reading obtained. And constant reading was noted. The measurements of pH of each formulation were replicated two times.^{44, 45}

7. Drug content

The drug content was determined by taking 1gm of gel in 10 ml volumetric flask diluted with methanol. 2 ml of stock solution was mixed with 1 ml of Folin- Ciocalteu reagent (previously diluted with distilled water 1:10 v/v) and 1 ml (7.5g/l) of sodium carbonate. The mixture was vortexed for 15s and allowed to stand for 15min for colour development. The absorbance was measured at 765 nm using a spectrophotometer.^{46, 47}

8. Antimicrobial studies

The well diffusion method was used to determine the antibacterial activity of the polyherbal gel prepared from fruits of *Terminalia chebula* and *Phyllanthus emblica* using standard procedure. Three concentration- 25, 50

and 100mg/ml, were used for antimicrobial studies. The plates were incubated at 37°C for 24 hr. and then examined for clear zones of inhibition around the wells with particular concentration of drug.^{48, 49}

9. Stability Study

The stability study was performed as per ICH guidelines. The formulated gel were filled in the collapsible tubes and stored at different temperatures and humidity conditions, viz. 25°C $\pm$ 2°C/ 60% $\pm$ 5% RH, 30°C $\pm$ 2°C/ 65% $\pm$ 5% RH, 40°C $\pm$ 2°C/ 75% $\pm$ 5% RH for a period of six months and studied for appearance, pH, viscosity and spreadability.⁵⁰

RESULTS

Preparation of extracts

Hydroalcoholic extracts of *Terminalia chebula* and *Phyllanthus emblica* fruits were prepared via maceration method. Prepared Hydroalcoholic extracts were stored in cool place in tightly closed glass containers. Percentage yields were calculated.

Table 2: % Yield of hydroalcoholic extracts

S. No.	Hydroalcoholic Extracts	% Yield (w/w)
1	<i>Terminalia chebula</i> extract	5.89
2	<i>Phyllanthus emblica</i> extract	4.26

Phytochemical screening of extract

A small portion of the dried extracts were subjected to the phytochemical test using Kokate (1994) methods to test for alkaloids, glycosides, phenol, saponins, flavonoids and carbohydrate separately for extracts of all samples. Small amount of each extract is suitably resuspended into the sterile distilled water to make the concentration of 1 mg per ml.

Table 3: Result of Phytochemical screening of hydroalcoholic extracts

S. No.	Constituents	<i>T. chebula</i>	<i>P. emblica</i>
1.	Alkaloids	-ve	+ve
2.	Glycosides	-ve	+ve
3.	Flavonoids	+ve	+ve
4.	Diterpenes	+ve	+ve
5.	Phenol	+ve	+ve
6.	Amino Acids	-ve	+ve
7.	Carbohydrate	+ve	+ve
8.	Proteins	-ve	+ve
9.	Saponins	+ve	+ve
10.	Oils and fats	-ve	-ve

Estimation of total phenol and flavonoid content

The total phenolic content of the extract was estimated using the modified Folin-Ciocalteu method. A standard curve was prepared using gallic acid (5–25 µg/ml). The extract (1 mg/ml) reacted with Folin-Ciocalteu reagent and sodium carbonate, and the absorbance was measured at 765 nm after 15 minutes. Phenolic content was expressed as gallic acid equivalents (GAE).

Total Phenolic content (TPC)

The content of total phenolic compounds (TPC) content was expressed as mg/100mg of gallic acid equivalent of dry extract sample using the equation obtained from the calibration curve: $Y = 0.041X + 0.002$, $R^2 = 0.999$, where X is the gallic acid equivalent (GAE) and Y is the absorbance.

Total flavonoid content estimation (TFC)

Total flavonoid content was determined using the aluminium chloride method. A standard curve was prepared with quercetin (5–25 µg/ml). The extract (1 mg/ml) was reacted with 2% $AlCl_3$ solution, and after 15 minutes at room temperature, absorbance was measured at 420 nm. Flavonoid content was expressed as quercetin equivalents (QE).

The content of total flavonoid compounds (TFC) content was expressed as mg/100mg of quercetin equivalent of dry extract sample using the equation obtained from the calibration curve: $Y = 0.06X + 0.019$, $R^2 = 0.999$, where X is the quercetin equivalent (QE) and Y is the absorbance.

Table 4: Total Phenolic and Total Flavonoid Content

S. No.	Solvents→ Bioactive compound↓	Hydroalcoholic extracts	
		<i>T. chebula</i>	<i>Pemblica</i>
1.	Total Phenol (Gallic acid equivalent (GAE) mg/100mg)	1.020	0.956
2.	Total flavonoid (Quercetin equivalent (QE) mg/100mg)	0.746	0.565

Formulation

Polyherbal gel formulations were developed using a combination of medicinal plant extracts known for their beneficial properties (e.g., anti-inflammatory, antioxidant). These extracts were incorporated into a gel base. The ingredients were blended to form a smooth, homogeneous gel and stored in collapsible tubes for further evaluation. Prepared formulations were termed as PHG1-PHG6.

1. Evaluation of Polyherbal Gel

A polyherbal gel was evaluated for its key physical properties. The formulation exhibited a uniform color, smooth texture, and good homogeneity without clogging. It was easily washable with water, indicating good washability. Extrudability was satisfactory, with the gel smoothly dispensing from collapsible tubes upon manual pressure.

2. Appearance and consistency:

The physical characters were visually checked for the appearance and consistency of Polyherbal gel formulations (PHG1-PHG6) and observations were reported.

Table 5: Results of Physical and Rheological Characteristics

Formulation	Colour	Clogging	Homogeneity	Texture
PHG1	Dark brown	Absent	Good	Smooth
PHG2	Dark brown	Absent	Good	Smooth
PHG3	Dark brown	Absent	Good	Smooth
PHG4	Dark brown	Absent	Good	Smooth
PHG5	Dark brown	Absent	Good	Smooth
PHG6	Dark brown	Absent	Good	Smooth

All of the formulations, i.e. PHG1-6 have clear dark brown color, with no clogging, good homogeneity and smooth texture.

3. Washability and Extrudability

Formulations were applied on the skin and then ease and extent of washing with water was checked manually and observations were reported. (Table 6)

Collapsible metal tubes filled with gel formulations were pressed to extrude the material and the extrudability of the formulations was reported. (Table 6)

Table 6: Washability and extrudability of the gel formulation

Formulation	Washability	Extrudability
PHG1	Good	Average
PHG2	Good	Average
PHG3	Good	Average
PHG4	Good	Average
PHG5	Good	Average
PHG6	Good	Average

All the gel formulations showed good washability as well as extrudability.

Table 7: Spreadability of gel formulations

Formulation	Spreadability (g.cm/sec)
PHG1	18.54±0.01
PHG2	17.53±0.01
PHG3	15.73±0.02
PHG4	16.13±0.01
PHG5	15.22±0.02
PHG6	12.20±0.02

In all above formulations of gel the spreadability of PHG6 is good as compared to other formulations.

4. Determination of pH

The pH of the anti-acne gels was determined by digital pH meter. The measurements of pH of each formulation were replicated three times.

Table 8: Determination of pH

Formulation	pH
PHG1	6.65± 0.02
PHG2	6.80±0.01
PHG3	6.87±0.01
PHG4	6.75±0.02
PHG5	7.57±0.02
PHG6	7.00±0.01

The above formulation of topical gels has different pH value for different formulation.

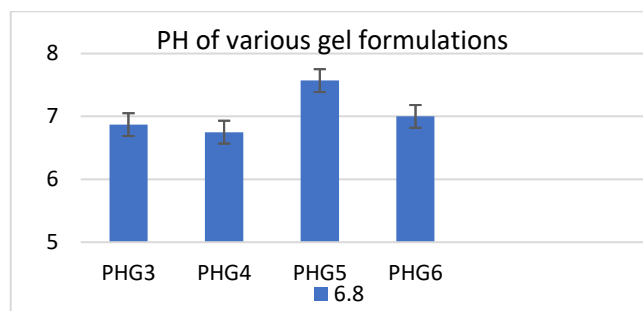


Figure 1: PH of various gel formulations

5. Determination of Viscosity

Viscosity determined by the Visco meter and readings in the table.

Table 9: Results of Viscosity

Formulation	Viscosity (cps)
PHG1	3523±25
PHG2	3363±15
PHG3	3443±18
PHG4	3421±20
PHG5	3248±10
PHG6	3714±12

In the above formulations, the viscosity of different samples of gel was determined and found that there is an increase in viscosity. The formulation PHG6 has good viscosity.

6. Determination of phenol content:

Table 101: Results of phenol content using Folin-Ciocalteu method

Formulation	% Phenol content
PHG1	88.12
PHG2	91.23
PHG3	78.20
PHG4	85.67
PHG5	67.23
PHG6	97.23

In the above formulation of different gels, the percentage of drug content was found that PHG6 has maximum percentage of Phenol.

7. Antimicrobial activity of optimized formulation

The present investigation in this research work, the Anti-acne activity of polyherbal gel of fruits of *Terminalia chebula* and *Phyllanthus emblica* were evaluated against *Propionibacterium acnes* pathogens used under present study. The polyherbal gel obtained from plant used to suitably dilute upto the concentrations of 100, 50 and 25 milligram per ml and applied on to the test organism

using well diffusion method. Results of the experiment are being concluded in the Table, which clearly shows the anti-acne activity of Hydroalcoholic extracts of fruits of

Terminalia chebula and *Phyllanthus emblica* against *Propionibacterium acnes* bacterial strain used in present work.

Table 11: Anti-acne activity of marketed gel and polyherbal gel formulation against *Propionibacterium acnes*

S. No.	Formulation	Zone of inhibition		
		100mg/ml	50 mg/ml	25mg/ml
1.	Clintop (Marketed gel)	17±0.5	15±0.94	12±0.57
2.	Polyherbal gel	18±0.57	16±0.86	14±0.5

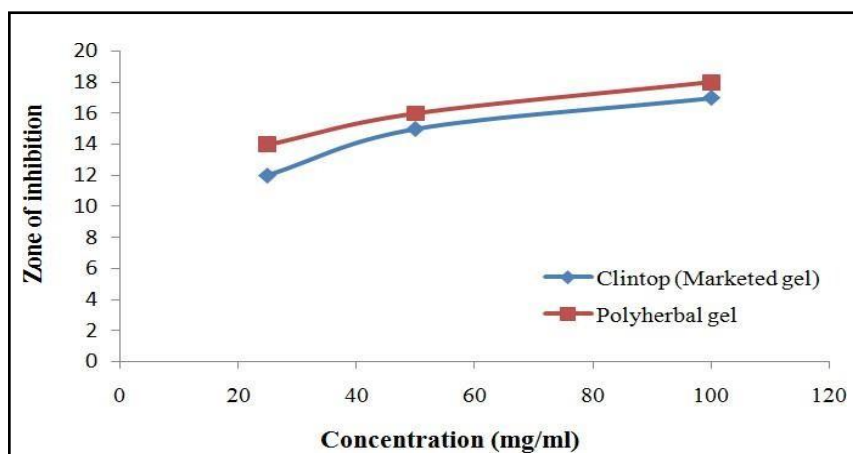


Figure 2: Graph of Anti-acne activity of marketed gel and polyherbal gel



Figure 3: Photo plates of Clintop.

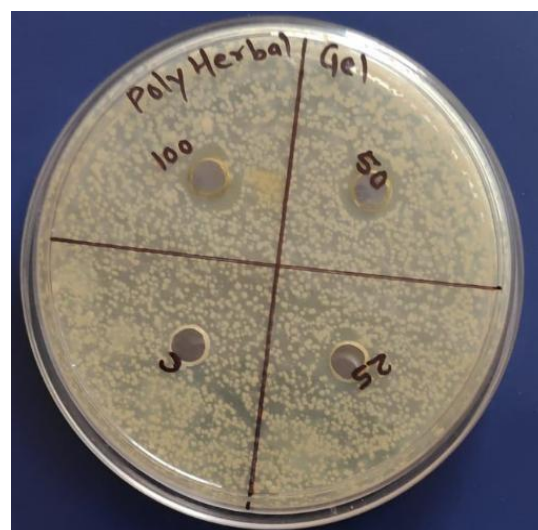


Figure 4: Photo plates Polyherbal gel

8. Stability Studies

Table 12: Stability Studies

Formulation Code	Months	Spreadability	pH
PHG-6	I	12.56±0.45	6.9±0.2
	II	13.25±0.65	6.8±0.3
	III	13.65±0.23	6.5±0.1
	IV	13.14±0.56	6.8±0.5
	V	14.25±0.74	6.9±0.2
	VI	14.25±0.65	7.2±0.1

CONCLUSION:

The primary objective of this research was to develop and evaluate a safe, effective polyherbal topical gel incorporating *Terminalia chebula* and *Phyllanthus emblica* extracts for the treatment of acne vulgaris. The gel developed using Carbopol 940 exhibited excellent homogeneity, consistent texture, satisfactory washability, smooth extrudability, and ideal spreadability—demonstrating it is pharmaceutically acceptable for topical use. Quantitative analysis revealed high levels of total phenolics (gallic acid equivalents) and flavonoids (quercetin equivalents), confirming the retention of valuable antioxidant compounds instrumental in combating acne-related inflammation. In vitro assays demonstrated notable inhibitory effects of the optimized gel against *Propionibacterium acnes*, validating the antimicrobial potential of the polyherbal combination and supporting its traditional use in acne therapy. The gel's pH fell within the skin-friendly range, and its viscosity was ideal for topical application—ensuring both user comfort and effective delivery of active compounds. Preliminary stability profiling indicated that the formulation remained consistent under standard storage conditions. Moreover, its natural herbal composition suggests a favorable safety profile compared to conventional synthetic acne treatments.

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Author's Contributions

Dr. Alok Khunteta: Conceptualization and supervision of the study.

Amit Kumar Sharma: Experimental work and data collection.

Dr. Surendra Kumar Swarnkar: Manuscript writing, literature review, and correspondence.

Deepa Gupta: Analytical support and interpretation of results.

Puneet Gupta: Statistical analysis and formulation design.

Conflicts of Interest: The authors declare that there are no competing interests or conflicts of interest related to this study.

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Ethical Approval: Not applicable. This study does not involve any human or animal participants.

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