

Design, Formulation and Evaluation of a Polyherbal Topical Gel for Management of Acne Vulgaris.

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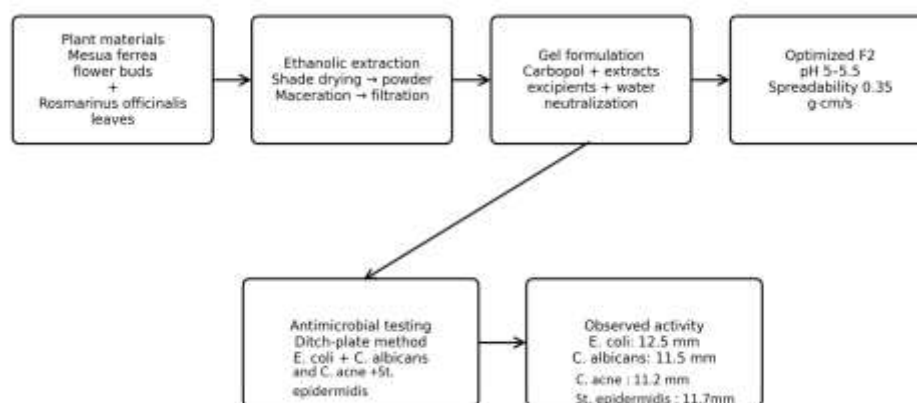
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Abstract

Background: Acne vulgaris is a long-term inflammatory condition of the pilosebaceous unit that includes inflammation, microbial colonization, follicular hyperkeratinization, and altered sebum production. Research on medicinal plants with antibacterial and anti-inflammatory properties has been stimulated by the growing demand for well-tolerated topical substitutes. **Objective:** The goal of this work was to create and test a polyherbal topical gel using ethanolic extracts of *Rosmarinus officinalis* leaves and *Mesua ferrea* flower buds. **Methods:** Plant materials were pulverized, shade-dried, and extracted using ethanolic maceration. Triethanolamine was used to neutralize the extracts after they were dispersed into a gel based on carbopol. The appearance, consistency, pH, spreadability, and extrudability of the formulations were evaluated. The ditch-plate method was used to assess antimicrobial activity against *Candida albicans* and *Escherichia coli*, and the results were compared with a commercial Clindamycin gel. **Results:** According to the optimized formulation composition, the formulation chosen as F2 had 2.50 g of aloe vera gel, 1.00 g of rosemary extract, and 1.50 g of *M. ferrea* extract. F2 had a yellowish-brown color, outstanding consistency, great extrudability, spreadability of 0.35 g·cm/s, and a skin-compatible pH of 5–5.5. The manufactured comparator displayed zones of inhibition of 18.5 and 16.5 mm, respectively, while the reported zones of inhibition for the formulated gel were 11.2 mm against *C. acne*, 11.7 mm against *St. Epidermidis*, 12.5 mm against *E. coli* and 11.5 mm against *C. albicans*. **Conclusion:** The investigation shows that adding extracts from *M. ferrea* and *R. officinalis* to a topical gel with acceptable initial physicochemical characteristics and quantifiable antibacterial activity is feasible. With this, optimized F2 formulation has shown greater anti-acne efficacy against the acne causing bacteria as compared with marketed formulation...

Keywords: Acne vulgaris; *Mesua ferrea*; *Rosmarinus officinalis*; Polyherbal gel; Carbopol; Antimicrobial activity; Topical formulation..

Graphical abstract showing plant extraction, gel development, optimization of F2 and preliminary antimicrobial evaluation



Introduction

A prevalent chronic inflammatory condition of the pilosebaceous unit, acne vulgaris primarily affects young adults and adolescents. Comedones and inflammatory lesions, such as papules and pustules, are its defining characteristics. It can cause long-term scarring and psychological distress. According to current research, the pathophysiology of acne involves microbial involvement, including *Cutibacterium acnes*, increased sebum production, altered follicular differentiation, and inflammation. According to often cited epidemiological figures, 85% of adolescents are thought to be plagued by acne.[1–3]

Topical retinoids, benzoyl peroxide, and topical antibiotics are examples of evidence-based acne treatment; systemic treatments are only used in certain cases with moderate-to-severe acne. Since antimicrobial resistance and tolerability are still major concerns, current guidelines place a strong emphasis on logical combination therapy and reducing needless systemic antibiotic exposure.[4] These factors have sparked interest in alternative therapies utilizing phytochemicals and medicinal plants. Numerous herbal remedies can lessen both inflammatory and non-inflammatory acne lesions, according to a systematic analysis of clinical trials, but it also highlights the need for more robust research and established procedures.[5]

Mesua ferrea L. (Nagkesar) has a history of medicinal use and has demonstrated antimicrobial activity in experimental studies. Extracts of its flowers and other plant parts have shown activity against a range of bacterial organisms, and more recent phytochemical studies have identified bioactive constituents associated with antimicrobial effects.[6–9] *Rosmarinus officinalis* L. (rosemary; currently also classified as *Salvia rosmarinus*) contains phenolic diterpenes, phenolic acids and volatile constituents with reported antioxidant, antimicrobial and anti-inflammatory properties. Importantly, rosemary extract has been investigated specifically for suppression of *P. acnes*-induced inflammatory responses, supporting its relevance to acne-oriented formulation research.[10–12] Topical gels offer a practical semisolid dose form that can enhance skin residence and enable consistent application. Because they can create clear or translucent gels with beneficial rheological and application properties following neutralization, carbopol polymers are frequently utilized as gelling agents. Although their antimicrobial characteristics and techniques differ greatly, recent research has shown the viability of polyherbal anti-acne gels and other plant-based topical treatments.[13–15]

Therefore, the design, manufacture, and initial assessment of a polyherbal gel including ethanolic extracts of *M. ferrea* flower buds and *R. officinalis* leaves were the main objectives of this work.

2. Materials and Methods

2.1 Materials

Ethanolic extracts of *M. ferrea* flower buds and *R. officinalis* leaves served as the active botanical ingredients. Carbopol, triethanolamine, aloe vera gel, glycerin/propylene glycol, methyl and propyl parabens, and distilled water were among the formulation excipients reported.



Mesua ferrea



Rosemary



2.2 Collection and processing of plant materials

Leaves of *R. officinalis* and mature, contamination-free flower buds of *M. ferrea* were gathered, verified, and processed. After being shade-dried, the *M. ferrea* buds were ground into a fine powder and sieved through a #60 screen. According to the source material, shade drying takes about 6 to 8 weeks to complete. Rosemary leaves were pulverized, shade-dried for around 7–14 days, and then sieved using a #60 screen. The preservation of the plant material during processing was thought to be indicated by the retained distinctive color and scent. [16–17]

2.3 Preparation of ethanolic extracts

Ethanol was used in a maceration process to remove the powdered plant ingredients. The plant-to-solvent ratio, length of maceration, number of extraction cycles, extraction yield, concentration process were performed.[18]

2.4 Formulation of polyherbal gel

A dispersion-neutralization method was used to make the gel. After dispersing the carbopol in distilled water, the herbal extracts and other formulation ingredients were added. Distilled water was used to make up the final amount after triethanolamine was utilized as a neutralizer. According to the source, the final product is homogenous and appropriate for topical use.

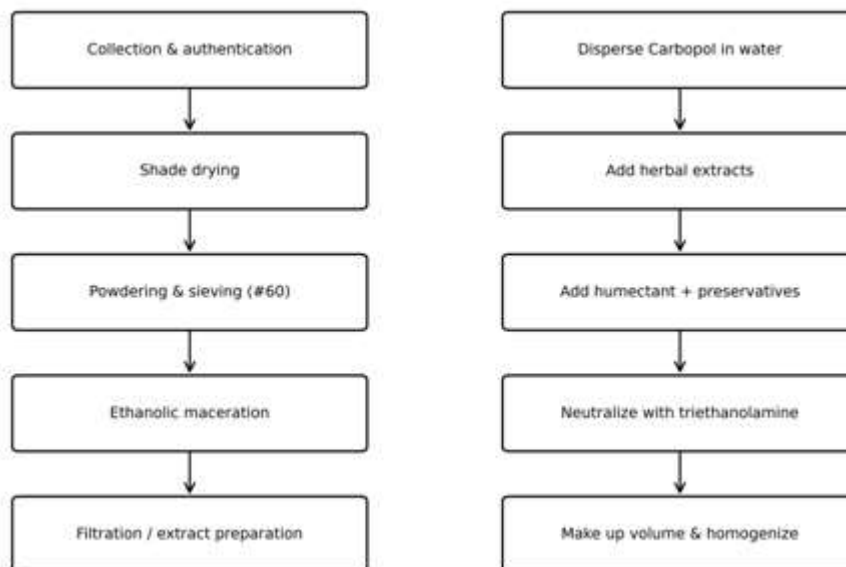


Figure 1: Schematic workflow for preparation of the polyherbal topical gel

2.5 Formulation composition

The five compositions of formulations were performed and screened for various evaluation parameters to optimize them. Based on evaluation parameter results, formulations will be selected to optimize and further study.

Table 1: Composition of the polyherbal gel formulations

Ingredient (g)	F1	F2	F3	F4	F5	Function
Carbopol	0.50	0.50	0.50	0.60	0.70	Gelling agent*
M. ferrea extract	1.00	1.50	2.00	2.20	2.50	Active botanical extract
Rosemary extract	0.80	1.00	1.20	1.40	1.60	Active botanical extract
Aloe vera gel	3.00	2.50	2.00	1.80	1.50	Skin-conditioning/gel component
Methyl paraben	0.02	0.02	0.02	0.02	0.02	Preservative
Propyl paraben	0.01	0.01	0.01	0.01	0.01	Preservative
Triethanolamine	q.s.	q.s.	q.s.	q.s.	q.s.	Neutralizer
Distilled water	q.s. to volume	q.s. to volume	q.s. to volume	q.s. to volume	q.s. to volume	Vehicle

2.6 Physicochemical evaluation

The pH, spreadability, extrudability, consistency, and appearance of the formulations were assessed. pH was taken into account when evaluating topical skin compatibility. The reported formula $S = m/Lt$, where m is the applied mass, L is the distance traveled, and t is the duration, was used to calculate spreadability. Extrudability was evaluated qualitatively based on how simple it was to remove the gel from the tube. Visual evaluation was used to evaluate appearance and uniformity.

2.7 Antimicrobial and Anti acne activity

The ditch-plate method was used to evaluate the antibacterial and antifungal activities against *Candida albicans*, *Escherichia coli*, *C. Acne* and *St. Epidermidis*. A central ditch was created and sterile agar plates were

manufactured. Microbial cultures were streaked perpendicular to the gel sample, which was positioned in the ditch. The zones of inhibition surrounding the ditch were measured in millimeters after being incubated under appropriate circumstances. In the stated trial, a commercially available clindamycin gel served as the standard comparison.

3. Results and Discussion

3.1 Plant material and extract preparation

The rosemary leaves and *M. ferrea* flower buds that were processed were said to be ripe, free of obvious contamination, and ready for extraction. The plant powders were said to maintain their distinctive physical characteristics following shade drying and sifting. The preservation of volatile elements during the indicated processing period is suggested by the rosemary material's retention of its distinctive scent.

3.2 Selection of the optimized formulation

The optimized formulation was identified as F2 based on the evaluation parameters of all formulations. F3 was thought to be more likely to increase viscosity and decrease spreadability, while F1 had the lowest concentration of *M. ferrea* extract among the main formulations. As a result, F2, which has 1.50 g *M. ferrea* extract, 1.00 g rosemary extract, and 2.50 g aloe vera gel, was chosen because it strikes a compromise between active botanical loading and desired application qualities.

3.3 Physicochemical characteristics

Table 2: Physicochemical evaluation of the selected F2 formulation

Parameter	Purpose	Reported observation (F2)
pH	Skin compatibility	5.0–5.5
Spreadability	Ease of application	0.35 g•cm/s ($S = 1 \times 7 / 20$)
Extrudability	Ease of removal from tube	Excellent
Appearance	Visual acceptability/homogeneity	Yellowish brown
Consistency	Texture and thickness	Good

Although pH by itself cannot determine dermatological safety, the observed pH of 5–5.5 falls within a mildly acidic range that is typically thought to be compatible with the skin surface. In the stated evaluation, appropriate handling characteristics are indicated by the spreadability value of 0.35 g•cm/s and the qualitative rating of excellent extrudability. The integration of botanical extracts is consistent with the yellowish-brown color.

3.4 Antimicrobial and Anti-acne activity

In the described ditch-plate test, the prepared gel demonstrated quantifiable inhibition against *Candida albicans*, *Escherichia coli*, *C. Acne* and *St. Epidermidis*. According to the statistics provided, the zones of inhibition are 12.5 mm and 11.5 mm, 11.2 and 11.7 respectively. For the commercial clindamycin gel, the equivalent values against *Candida albicans* and against *C. Acne*. Therefore, given the stated test conditions, the commercial comparator generated greater inhibition zones. The observed result successfully shown the F2 formulation is with greater antimicrobial and Anti-acne activity.

Table 3: Reported zones of inhibition for the marketed comparator and formulated F2

Microorganism	Marketed Clindamycin gel (mm)	Formulated F2 (mm)	Difference (mm)
<i>E. coli</i>	18.5	12.5	6.0
<i>C. albicans</i>	16.5	11.5	5.0
<i>C. acne</i>	11.6	11.2	4.0
<i>St. epidermidis</i>	12	11.7	3.0

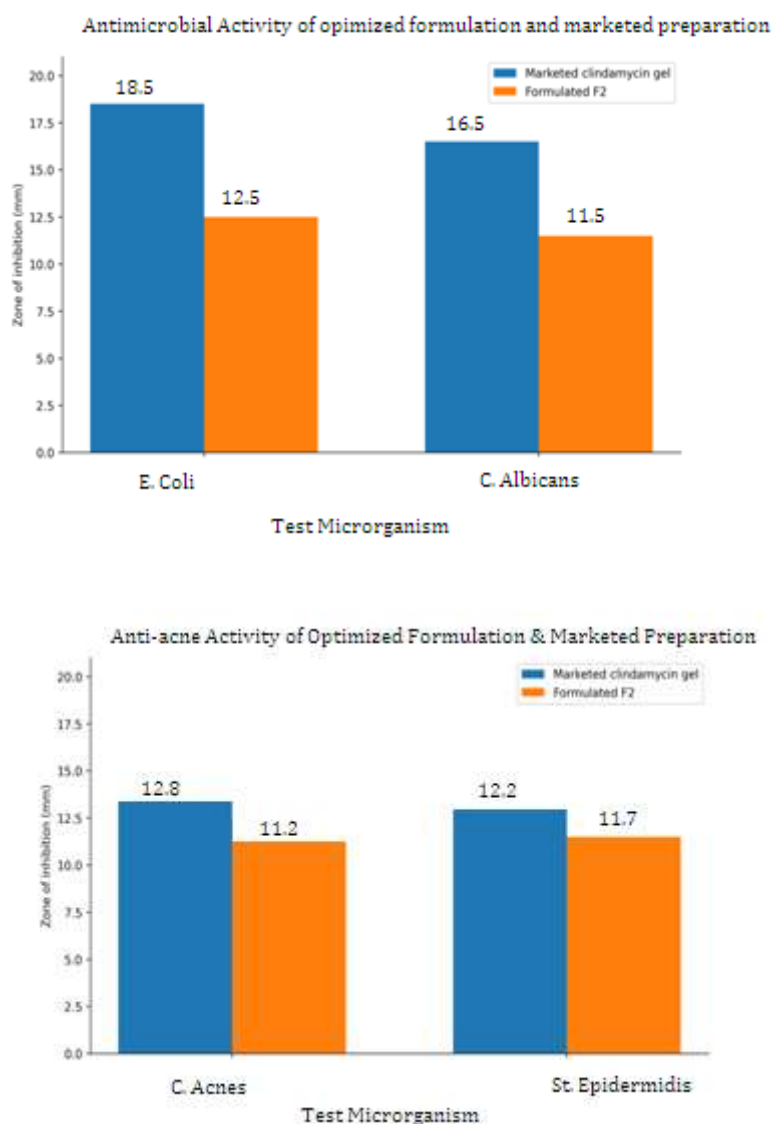


Figure 2: Comparison of reported inhibition zones produced by the marketed Clindamycin gel and formulated F2

3.5 Proposed mechanism of the polyherbal gel

The blend was conceptually created to target oxidative stress, inflammatory signaling, and microbial proliferation, all of which factors are related to acne. While rosemary has been shown to have antimicrobial, antioxidant, and anti-inflammatory properties, *M. ferrea* has been shown to possess antibacterial potential. Specifically, rosemary extract has been demonstrated in experiments to inhibit *P. acnes*-induced inflammatory reactions, offering mechanistic justification for its inclusion.

4. Conclusion

Using a Carbopol-based gel method, a polyherbal topical gel combining ethanolic extracts of *Rosmarinus officinalis* leaves and *Mesua ferrea* flower buds was effectively created. The formulation that was chosen as F2 had a reported pH of 5–5.5, spreadability of 0.35 g•cm/s, outstanding extrudability, a yellowish-brown color, and superb consistency. Additionally, in the reported ditch-plate assay, it generated inhibitory zones of against *E. coli*, *C. albicans*, *C. Acne*, and *St. Epidermidis*. Under the same described comparison, the commercial clindamycin comparator generated zones are nearby similar to optimized formulation.

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Conflict of Interest: There is no any conflict of interest..

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