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Phytotherapeutic face wash gel: Formulation and evaluation for acne treatment

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Abstract
The limitations and side effects of synthetic anti-acne products have led to growing interest in herbal alternatives. This study reports the formulation and assessment of a herbal face wash gel containing aqueous extracts of *Aloe vera*, *Curcuma longa* (turmeric), *Ocimum tenuiflorum* (tulsi), and *Azadirachta indica* (neem). Three formulations (F1–F3) were developed using different polymers and assessed for physical parameters including color, consistency, wash ability, pH, spread ability, and viscosity. Among all, formulation F2 demonstrated optimal characteristics. This study highlights the potential of polyherbal combinations in the development of safe and effective topical anti-acne formulations.

Keywords: Anti-acne gel, neem, Tulsi, turmeric, Aloe vera, polyherbal formulation, evaluation

1. Introduction
A persistent inflammatory condition of the pilosebaceous units, acne vulgaris mainly affects adolescents but can persist into adulthood, especially in individuals aged 20 to 30 years [1]. It is among the most common skin disorders globally, with an estimated 85% of adolescents experiencing at least mild symptoms, and up to 15% of women affected into their 40s [2]. Lesions typically manifest in regions rich with sebaceous glands such as the face, chest, shoulders, and upper back.
Clinically, acne lesions include inflammatory papules, pustules, nodules, and occasionally cystic lesions, as well as non-inflammatory comedones (both open and closed [3]. The four principal pathogenic mechanisms in acne development are:

1. Follicular hyperkeratinization, which blocks the sebaceous ducts and forms comedones;
2. Increased sebum production, primarily under the influence of androgens;
3. Colonization by *Cutibacterium acnes* (formerly *Propionibacterium acnes*), which hydrolyzes triglycerides in sebum, releasing pro-inflammatory free fatty acids; and
4. Inflammation, mediated by both innate and adaptive immune responses, including TLR2 activation and cytokine release [4].

Additionally, Staphylococcus epidermidis, a commensal skin bacterium, has also been implicated in acne through biofilm formation and immune evasion, which may contribute to lesion persistence and resistance to therapy [5]. Acne is thus not merely a cosmetic issue but a condition with psychosocial impacts, including depression, low self-esteem, and anxiety, particularly in teenagers.
Conventional treatments include Benzoyl peroxide, topical retinoids, antibiotics, and oral isotretinoin, but these are often associated with adverse consequences like skin irritation, photosensitivity, and bacterial resistance. As a result, there is a growing interest in plant-based therapeutics, particularly those with antibacterial, antioxidant, keratolytic, and anti-inflammatory properties [6].
The medicinal plants selected in this study, *Azadirachta indica* (Neem), *Ocimum tenuiflorum* (Tulsi) [7], *Curcuma longa* (Turmeric) [8], and *Aloe vera* [9] have been extensively reported in traditional systems of medicine for treating skin infections and inflammation. These botanicals have demonstrated significant anti-acne activity in various *in vitro* and *in vivo* studies, offering promising alternatives to conventional pharmacotherapy.
This study was undertaken to formulate a polyherbal face wash gel using these extracts and to evaluate its physicochemical and functional properties, aiming to develop an effective and safe herbal skincare product.

2. Materials and Methods

2.1. Materials

2.1.1. Collection of Materials and Instrumentation

Plant materials including dried fresh aloe vera leaves, rhizomes of *Curcuma longa* (turmeric), *Ocimum tenuiflorum* (tulsi), and *Azadirachta indica* (neem) leaves were collected from the Sasyakashi medicinal garden of GM Institute of Pharmaceutical Sciences and Research (GMIPSR), Davangere, and authenticated by a qualified botanist. Analytical grade chemicals such as methanol, glycerin, lemon oil, sodium benzoate, triethanolamine, and natural polymers like xanthan gum and tragacanth gum were procured from Vasa Scientific Pvt. Ltd., Bangalore. A digital pH meter (Yamto, Model: PHS-3C) was used for pH measurement, and a digital viscometer (Yamto, Model: NDJ-8S) was employed to determine the viscosity of the formulated gel.

2.1.2. Preparation of Herbal Extracts

- **Neem and Tulsi:** 10 g of dried, powdered leaves were macerated with 100 mL methanol for 24 h with intermittent shaking. The extracts were filtered and concentrated under reduced pressure.
- **Turmeric:** 10 g of powdered rhizome underwent a similar maceration and filtration process.
- **Aloe vera:** The gel was freshly extracted from leaves and homogenized in a blender to remove lumps.

2.2. Methods

2.2.1. Formulation of Face Wash Gel

The gel base was prepared by dispersing Aloe vera gel in distilled water with glycerin under continuous stirring. Herbal extracts were then added. Polymer was incorporated gradually to achieve gel consistency. pH was adjusted using triethanolamine. Sodium benzoate was added as a preservative, and lemon oil as a fragrance.

Table 1: Composition of polyherbal anti-acne face wash gel formulations (F1–F3)

Ingredient	Quantity per 100 g	Function	F1 formulation	F2 formulation	F3 formulation
Aloe vera gel	15 mL	Gelling agent, moisturizer	✓	✓	✓
Distilled water	q.s.	Solvent	q.s.	q.s.	q.s.
Glycerine	3 mL	Humectant	✓	✓	✓
Neem extract	3 mL	Antibacterial agent	✓	✓	✓
Tulsi extract	1.5 mL	Antioxidant, antimicrobial	✓	✓	✓
Turmeric extract	1.5 mL	Anti-inflammatory	✓	✓	✓
Polymer	0.3 g	Thickening agent	Xanthan + Tragacanth gum	Tragacanth gum	Xanthan gum
Sodium benzoate	4–5 drops	Preservative	✓	✓	✓
Lemon oil	0.1 mL	Fragrance	✓	✓	✓

Each formulation was prepared using consistent quantities of active herbal components and excipients, while varying the gelling agents to evaluate their impact on the physicochemical characteristics of the final gel. F1 contained a combination of xanthan and tragacanth gum, F2 used tragacanth gum alone, and F3 incorporated xanthan gum alone. All formulations included plant extracts with known antimicrobial, anti-inflammatory, and antioxidant properties for synergistic anti-acne activity.

2.2.2. Evaluation methods

2.2.2.1. Physical Parameters

Colour, appearance, and consistency were assessed visually [10].

2.2.2.2. pH Determination

The pH of 1% gel solution was measured using a calibrated digital pH meter [11].

2.2.2.3. Spreadability

Measured using the formula:

$$S = \frac{M \times L}{T}$$

Where S is spreadability (g.cm/s), M is the applied weight (20 g), L is the length of glass slide (6.5 cm), and T is the time [11].

2.2.2.4. Washability

Ease of removal was assessed by applying a small amount of gel on skin followed by washing with tap water [11].

2.2.2.5. Viscosity

Viscosity was determined using a digital viscometer at room temperature

3. Results and Discussion

3.1. Results

The stepwise preparation and evaluation process of the polyherbal anti-acne face wash gel is visually represented in Figure 1

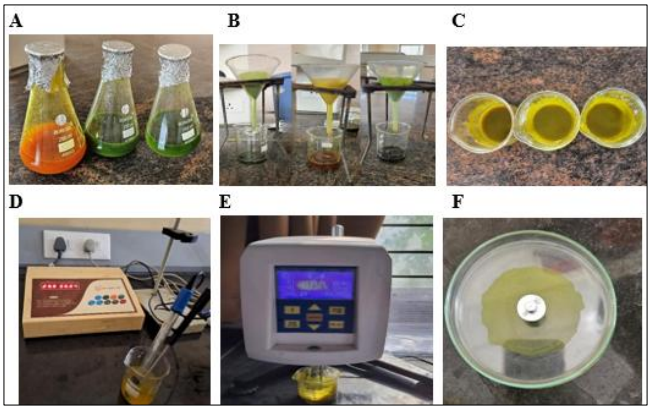

Fig 1: Stepwise formulation and evaluation of polyherbal anti-acne face wash gel

Maceration (A) was carried out using methanol to extract phytoconstituents from powdered plant materials. The resulting extracts were filtered using standard filtration assemblies (B). The final product (C) exhibited a uniform yellowish-green color and semisolid consistency. Evaluation

procedures included pH determination (D) using a calibrated digital pH meter, viscosity measurement (E) with a digital viscometer to assess flow behavior, and spreadability testing (F) to evaluate the gel's ability to distribute uniformly over the skin surface.

The formulated polyherbal face wash gels (F1–F3) were subjected to physicochemical evaluation to determine the influence of different polymer bases on their appearance, texture, ease of application, and rheological behavior. The results of these evaluations are summarized in Table 2.

Table 2: Physicochemical evaluation of polyherbal face wash gel formulations (F1–F3).

Formulation	Polymer	Colour	Consistency	Washability	pH	Spreadability (g.cm/s)	Viscosity (rpm)
F1	Xanthan + Tragacanth gum	Yellowish-green	Semisolid	Good	5.21	16.5	14528.20
F2	Tragacanth gum	Yellowish-green	Semisolid	Good	6.04	15.0	14616.20
F3	Xanthan gum	Yellowish-green	Liquid	Good	4.19	17.0	7474.68

Each formulation was prepared using different polymer bases and assessed for colour, consistency, washability, pH, spreadability, and viscosity. F2, formulated with tragacanth gum, exhibited optimal pH, spreadability, and viscosity, making it the most suitable formulation for topical application.

3.2. Discussion

The development of a polyherbal anti-acne face wash gel using *Curcuma longa* (turmeric), *Ocimum tenuiflorum* (tulsi), *and Azadirachta indica* (neem), and *Aloe vera* aimed to provide a natural alternative to conventional acne treatments. These medicinal plants were chosen based on their established pharmacological properties, including antimicrobial, anti-inflammatory, antioxidant, and skin-soothing effects—key factors in managing acne vulgaris.

Three gel formulations (F1–F3) were prepared using different gelling agents: xanthan gum, tragacanth gum, and their combination. All formulations showed acceptable sensory attributes such as colour and washability. The pH of the formulations ranged from 4.19 to 6.04. Notably, F2, prepared with tragacanth gum alone, had a pH of 6.04, closely matching the natural pH of human skin, and thus minimizing the risk of irritation.

Spreadability is a critical parameter for topical applications. Although F3 had the highest spreadability (17.0 g·cm/s), it lacked adequate consistency due to its liquid nature, likely caused by using xanthan gum alone. In contrast, F2 demonstrated a desirable semisolid consistency with balanced spreadability (15.0 g.cm/s) and the highest viscosity (14616.20 rpm), indicating better gel structure and stability. F1 showed moderate characteristics but fell short of the optimal pH and spreadability values.

These observations underscore the importance of polymer selection in topical gel formulations, as it directly affects viscosity, application feel, and stability. The performance of F2 suggests that tragacanth gum provides a stable, skin-compatible gel base ideal for incorporating active herbal constituents.

The therapeutic efficacy of the selected herbs is well-documented. Neem has been shown to inhibit *Cutibacterium acnes* and reduce inflammation [12]. Tulsi offers antioxidant protection and modulates immune responses [13]. Turmeric's active compound, curcumin, has proven antibacterial and anti-inflammatory effects [14], while *Aloe vera* supports hydration, healing, and barrier repair [15]. Collectively, these botanicals address multiple pathogenic pathways in acne, including microbial proliferation, oxidative stress, and inflammatory cascades.

4. Conclusion

This study successfully formulated and evaluated a polyherbal anti-acne face wash gel using extracts of Neem, Tulsi, Turmeric, and Aloe vera. Among the three formulations, F2—containing tragacanth gum—exhibited superior physicochemical characteristics, including optimal pH, semisolid consistency, suitable spreadability, and high viscosity. The combination of herbal extracts in this formulation offers a promising, multi-targeted approach for acne management with potential advantages over synthetic alternatives.

Based on its performance, F2 can be considered a safe and effective natural formulation for topical use in acne-prone skin. However, further investigations, including *in vitro* antimicrobial studies, skin irritation assessments, and long-term stability evaluations, are necessary to confirm its clinical applicability and commercial viability.

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