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Original Article

Development of a Topical Emulgel Containing Tulsi and Neem Oils: A Novel Approach for Acne Management

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ABSTRACT

Objectives: This research focused on formulating and assessing a silica-based herbal emulgel enriched with antimicrobial and anti-inflammatory agents, including tulsi (*Ocimum sanctum*) and neem (*Azadirachta indica*) oils, to manage acne vulgaris. **Materials and Methods:** A silica-based emulgel was synthesized using carbopol as the gelling agent, with tulsi and neem oils as key bioactive components. Tween 80 and Span 20 were incorporated as emulsifiers to stabilize the formulation. Four batches (F1-F4) were developed with varying ingredient concentrations and analyzed for consistency, spreadability, pH, viscosity, and washability. **Results:** Among the tested formulations, Batch F4 emerged as the most optimized, demonstrating a smooth texture, high spreadability, non-greasy characteristics, and excellent washability. Silica gel plays a crucial role in enhancing the structural stability and penetration of the formulation into the skin. Tulsi and neem oils exhibited significant antimicrobial and anti-inflammatory activities. The formulation Batch F4 showed optimal results with a pH of 5.0±0.2, spreadability of 13.6 g cm/s, and viscosity of 0.0171 Pa s. The formulation exhibited a non-greasy, smooth texture with excellent washability. The bioactive eugenol in *Tulsi* and nimbidin in *Neem* contributed to the observed benefits. **Conclusion:** The developed silica-based herbal emulgel demonstrated significant potential as an effective and user-friendly topical treatment for acne vulgaris. The integration of herbal bioactives with advanced drug-delivery technology presents a promising approach. Further research is warranted to establish clinical efficacy and explore its applications in skincare formulations.

Keywords: Silica-based emulgel, Acne vulgaris, Tulsi and neem oils, Antimicrobial and anti-inflammatory, Dermatological safety.

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INTRODUCTION

Acne vulgaris, commonly known as acne, is one of the most prevalent skin conditions. This chronic inflammatory disorder of the pilosebaceous skin affects the chest, back, and face. Eighty-five percent of individuals are affected, particularly teenagers (Canha *et al.*, 2020). The three primary causes of acne include increased sebum production, pore blockage-induced hyperkeratinisation, and the subsequent release of inflammatory chemicals into the skin. As various types of skin bacteria are removed from the follicle, bacterial colonization within the follicles activates additional commensals in the skin (Chen *et al.*, 2020). The three main Gram-positive bacteria implicated in skin bacterial colonization are *Staphylococcus aureus, Staphylococcus epidermidis*, and *Cutibacterium acnes* (previously known as *Propionibacterium acnes*). The pathogenesis and progression of acne are significantly influenced by *C. acnes*, which may trigger the immune response cascade and initiate inflammatory processes in infected cells (Fourniere *et al.*, 2020).

Cosmetics are products applied to the face, neck, and hands to enhance natural beauty while preserving skin health and maintaining the body's natural structure and function (Ko, 1998). The use of herbal cosmetics is becoming increasingly popular, as dermatologists endorse their safe application and minimal side effects, making them clinically effective (Kumar *et al.*, 2012). Herbal medicines remain an integral part of traditional healthcare, particularly when conventional approaches fall short in treating chronic conditions. Bauhinia racemosa, for example, has demonstrated diverse pharmacological activities including anti-inflammatory, hepatoprotective, antioxidant, and antimicrobial effects (Tripti and Sahu, 2015). Numerous skincare

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products are available on the market, including sunscreen, anti-aging treatments, anti-wrinkle creams, anti-acne solutions, and those featuring natural ingredients (Joshi and Pawar, 2015).

Common cosmetics, including lotions, creams, and fragrances, are applied to the skin for aesthetic and cleansing purposes. As a result, they enhance our appearance without disrupting physical makeup (Larsson *et al.*, 2007). Furthermore, these products include an emulsion and gel that improve solubility and skin penetration by allowing hydrophobic bioactive components to enter the aqueous phase (Malavi *et al.*, 2022). The benefits of both emulsions and drug gels are combined when an emulgel is used, offering a dual-controlled drug-release system (Dantas *et al.*, 2016; Kumar *et al.*, 2016).

Overall, after oxygen, silicon is the second most abundant element on Earth and the third most plentiful trace element in the human body (Jugdaohsingh *et al.*, 2008; Reffitt *et al.*, 1999). Silica offers advantages over conventional gel bases due to its porous structure, high surface area, and ability to enhance skin penetration, making it superior to carbopol-only systems for delivering hydrophobic herbal actives (Morais *et al.*, 2021). Emulgels are two-phase solutions that are ideal for acne-prone skin because of their non-greasy and lightweight textures.

The primary objective of this research is to create and test an herbal emulgel containing silica, tulsi oil, and neem oil (Chauhan *et al.*, 2010; Bhattacharya and Walia, 2020). These herbal ingredients are effective in treating acne due to their antibacterial, anti-inflammatory, and antioxidant properties. This study is novel in its integration of Tulsi and Neem oils-both known for their antimicrobial and anti-inflammatory potential-into a silica-based emulgel, aiming to exploit their synergistic effect for acne therapy.

MATERIALS AND METHODS

Materials

Jojoba oil, tulsi oil, and neem oil were procured from Paras Chemicals Ltd., Additional reagents, including silica gel, tween 80, span 20, and ethanol, were sourced from the School of Pharmacy, VU chemical storehouse.

Preparation Methods

Extraction of Tulsi Oil: Fresh *Ocimum sanctum* leaves were thoroughly washed and dried for 36 hr. The dried leaves were cut into small pieces and subjected to solvent extraction in a stirred-type batch reactor using methanol. The extracted oil was collected at specific intervals (Chauhan *et al.*, 2010).

Emulgel Preparation: After moderate stirring, Carbopol 934 was dissolved in filtered water, and the pH was adjusted to between 6 and 6.5. Span-20 was dissolved in liquid paraffin to create the oil phase, while Tween-20 was added to filtered water to form

Figure 1: Emulgel preparation process.

Table 1: Formulation of herbal silica-based anti-aging emulgel.

Ingredients	F1	F2	F3	F4
Tulsi oil %v/v	0.1	0.2	0.3	0.4
Jojoba oil %v/v	0.4	0.5	0.6	0.7
Neem oil q.s. (mL)	10	10	10	10
Silica gel %w/v	2.5	3	3.5	4
Carbopol %w/v	0.2	0.3	0.4	0.5
Preservatives	0.001	0.001	0.001	0.001
Water	q.s.	q.s.	q.s.	q.s.

the aqueous phase. The medication was dissolved in ethanol, and the preservatives were dissolved in propylene glycol before being combined with the aqueous phase. The two phases were independently heated to 70°C to 80°C and then mixed while being constantly stirred. The final emulgel was created by blending the gel and the resulting emulsion in a 1:1 ratio (Bhattacharya *and* Walia, 2020) (Figure 1).

Development of an Optimal Topical Formulation: A suitable formulation should ensure effective topical targeting, smooth consistency, ease of application, non-greasy feel, stability, and washability. The silica-based emulgel was optimized to meet these criteria. Four batches (F1-F4) were developed with varying ingredient concentrations (Table 1).

RESULTS AND EVALUATION METHODS OF THE FORMULA

Evaluation of the physicochemical parameters and standardization of herbs.

(a) **Humidity:** 2 g of the sample were weighed, dried at 105°C for 2 hr, cooled in a desiccator, and reweighed. The weight loss was recorded as moisture content.

Formula: Moisture% = (Weight before drying - Weight after drying) / Initial weight × 100

(b) **Total ash:** 3 g of the sample were incinerated at 600°C for 3 hr. The remaining ash content was weighed and calculated as a percentage.

Formula: Total Ash % = (Weight of Ash) / (Weight of Sample) × 100

(c) **Acid insoluble ash:** After treatment with hydrochloric acid, the ash was filtered, dried, and burned again. The amount of acid-insoluble ash in the residue was determined by weighing it.

Formula: Acid Insoluble Ash % = (Weight of Acid-Insoluble Ash) / (Weight of Sample) × 100

(d) **Characterization of oil:** Properties of the oils used are listed in Table 2.

Saponification value: The saponification value indirectly indicates the molecular weight and fatty acid chain length, measuring the potassium hydroxide required to saponify 1 g of oil.

Formula: Saponification Value = 28.05 × (Blank Reading - Sample Reading) / Weight (Kokate *et al.*, 2017; Indian Pharmacopoeia, 2018).

(e) The physicochemical evaluation of Tulsi leaves is summarized in Table 3.

Evaluation of the prepared formulation

Each formulation was tested for pH, viscosity, spreadability, and washability to determine the optimal batch.

(a) **pH Determination:** A measured quantity of oil was diluted with water, and pH was recorded using a pH meter (Figure 2).

(b) **Viscosity Measurement:** Viscosity was determined using a Brookfield digital viscometer.

(c) **Spreadability Assessment:** Spreadability was analyzed using a glass slide apparatus, where the time required for the slides to separate under a given weight was recorded. The results are presented in Table 4 (Figure 3).

A measure of cream was applied to the fixed glass slide to evaluate its spreadability. 1 kg of weight was placed on the movable glass slide, which was connected to a pan, for 5 min while positioned over the fixed glass slide. After adding 50 g of weight to the pan,

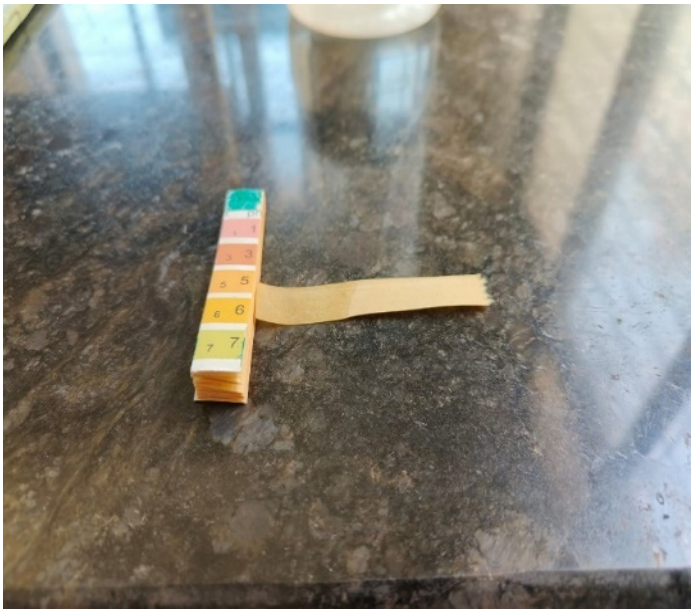

Figure 2: pH Testing.

Table 2: Properties of used oils.

Properties	Jojoba oil	Tulsi oil	Neem oil
Saponification value	61.5	187.0	190.0
Colour	Pale yellow	Clear	Clear
Odor	Characteristic	Characteristic	None
State	Liquid	Liquid	Liquid
% yield	-	13%	-

Table 3: Evaluation of the physicochemical parameters and standardization of tulsi leaf.

Characteristics	Herb	Requirements	Results	Remarks
Moisture % by mass, Max.	Tulsi leaf	16.26	15.88	Passes
Total ash (on dry basis), % by mass, Max.	Tulsi leaf	15.21	14.75	Passes
Acid insoluble ash (on a dry basis), % by mass, Max.	Tulsi leaf	17.6	16.80	Passes

Table 4: Evaluation of different batches of herbal Emulgel.

Formulation	Consistency	Texture	Spreadability	Washability	pH	Viscosity
F1	Poor	Smooth	Poor	Poor	5.0±0.3	0.0164
F2	Poor	Smooth	Poor	Poor	5.0±0.3	0.0164
F3	Good	Smooth	Good	Good	5.0±0.1	0.0191
F4	Good	Smooth	Good	Good	5.0±0.2	0.0171

Table 5: The ingredients contents of the F4 batch.

Sl. No.	Ingredients used	Quantities (%)
1	Tulsi oil (%v/v)	0.4%
2	Jojoba oil (%v/v)	0.7%
3	Neem oil(%v/v)	10%
4	Silica gel (%w/v)	4%
5	Tween 80	1.3%
6	Span 20	0.5%
7	Carbopol 934	0.5%
8	Liquid paraffin	7.5%
9	Propylene glycol	5%
10	Ethanol	2.5%
11	Methyl paraben	0.001%
12	Propyl paraben	0.003%
13	Purified water	q.s.

the time for the slides to separate was recorded. The results are presented in Table 4.

Formula: $S = W \times L / t$

Where

S = Spreadability,

W = Weight attached to the top slide,

L = Length of slide (Smith and Johnson, 2023).

It was found that Formula number 4 has all the qualities that topical application needs, and below are the ingredients used in specific quantities mentioned.

Optimized Formulation: The formulation exhibited a non-greasy, smooth texture with excellent washability (Figure 4). The ingredients of Batch F4 are detailed in Table 5.

Figure 3: Spreadability Testing.

DISCUSSION

The physicochemical evaluation of Tulsi leaves confirmed compliance with quality standards, showing a moisture content of 15.88%, total ash of 14.75%, and acid-insoluble ash of 16.80%. The oils used- Tulsi, Neem, and Jojoba- demonstrated favorable saponification values and clarity, supporting their use in topical preparations.

Among the four formulations developed, Batch F4 exhibited the most desirable characteristics, including an appropriate pH (~5.0±0.2), spreadability (13.6 g·cm/s), and viscosity (0.0171 Pa·s), as well as excellent washability and no visible signs of skin irritation.

The therapeutic effect of Tulsi oil is primarily attributed to its active constituent eugenol, which is reported to have antibacterial and anti-inflammatory properties. Similarly, Neem oil contains nimbidin, a known antimicrobial agent. These phytochemicals, when combined in a stable emulgel matrix, may act synergistically to reduce inflammation and bacterial colonization in acne-prone skin, based on previously reported literature.

The incorporation of silica gel significantly enhanced the emulgel's structural and dermal penetration characteristics. As a porous,

Figure 4: Emulgel.

biocompatible carrier, silica facilitates the sustained release and improved bioavailability of lipophilic actives, ensuring prolonged skin retention and therapeutic action.

While the formulation results suggest promising potential, several limitations must be acknowledged. No *in vivo* clinical trials were conducted, and the accelerated stability and microbial limit tests- important for commercial translation- were not included. These gaps provide direction for future studies on regulatory compliance and clinical validation.

CONCLUSION

This study successfully developed and evaluated a silica-based herbal emulgel incorporating Tulsi, Neem, and Jojoba oils. Among the tested batches, formulation F4 was found to be optimal, demonstrating favorable pH, spreadability, viscosity, and washability. Using silica gel improved the consistency and enhanced the delivery of phytoconstituents. The combination of herbal actives, eugenol from Tulsi and nimbidin from Neem, offers promising potential for antimicrobial and anti-inflammatory activity, as supported by literature, making it a promising candidate for topical acne therapy. Further work should include clinical trials, long-term stability testing, and regulatory safety assessments to validate the formulation's commercial and therapeutic applicability.

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CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest.

ABBREVIATIONS

MIC: Minimum Inhibitory Concentration; **q.s.:** Quantum sufficient.

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