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RESEARCH ARTICLE

# Formulation and Evaluation of Topical Antimicrobial Herbal Cream

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**Abstract:**
Throughout history, medicinal compounds have been sourced from plants, playing a crucial role in treating various ailments in humans and animals. Presently, a significant portion of hydrogels, pivotal in pharmaceutical drug development, utilize natural ingredients rather than synthetic ones. The Punica granatum L. plant's fruits have been extensively studied for their diverse medicinal advantages, encompassing wound healing, antifungal, anti-inflammatory, and antibacterial properties. Combining herbal extracts may enhance therapeutic effects compared to individual extracts. This study aims to formulate and evaluate a topical herbal cream with antibacterial, anti-inflammatory, and wound-healing attributes against microorganisms. Various parameters such as organoleptic properties, loss on drying, pH, diffusion study, stability study, spreadability, viscosity, consistency, and homogeneity are scrutinized for the herbal cream. The practical application of the prepared herbal cream will be further investigated *in vivo*.

**Keywords:** Antibacterial; Anti-inflammatory; Herbal cream; Wound healing.

## 1. Introduction

Transdermal and dermal drug delivery methods present promising alternatives to conventional drug administration techniques. When applied topically, drugs can exert either local or systemic effects. The efficacy of a topical dermatological formulation relies on the efficient absorption of the medication by the targeted organ, often the skin itself. To achieve the desired therapeutic effect with minimal systemic exposure, the drug must reach the target area at the appropriate concentration. However, the skin's natural barrier characteristics pose challenges to the transport of active chemicals, leading to impermeability issues. [1-4] Pharmaceutical companies are increasingly investing in the development of breakthrough medicines that can overcome the skin's inherent barrier functions. The skin, akin to the complexity of the brain, comprises a diverse array of cell types. Despite the ease of accessing the skin for drug delivery and research, certain aspects of transdermal drug infiltration remain unexplained. Further research is imperative to understand the precise pathways through which chemicals enter the body and how formulations can influence these processes. Modern technology has facilitated the production of numerous potential drugs through parallel synthesis and combinatorial chemistry.[5] Consequently, the pharmaceutical industry requires efficient and accurate methods to assess the tissue permeability potential of drug leads during the early stages of discovery. Conducting in vivo research on human skin is often impractical due to the invasiveness and high cost of biopsies. Algorithms can play a pivotal role in selecting optimal transdermal drugs, even in the absence of a complete understanding of skin permeability. While in vitro studies using human skin for evaluating drug diffusion and metabolism provide more reliable absorption data than those employing animal skin, some may choose to analyze the penetration capabilities of innovative candidate drugs using human skin. [6,7]

Routes of drug permeation through the skin include the transepidermal route, where intercellular passage is utilized, especially during the steady state of the stratum corneum, with drugs moving through narrow spaces within the skin [8, 9]. Another pathway is the transcellular route, sometimes considered an intracellular route, involving penetration by corneocytes and intercellular lipids. Compounds utilizing this route exploit the weaknesses in corneocytes, allowing for water-based openings, making hydrophilic compounds preferable for delivery [10, 11]. Additionally, the transappendageal route involves molecular movement through sweat glands, hair follicles, and sebaceous glands. The topical drug delivery system has gained increased attention in recent decades for treating various skin-related diseases. The objective is to limit the drug's impact to the skin's surface or within the skin, offering options like foams, sprays, medicated powders, solutions, and semi-solid formulations like medicated adhesive systems [12,13] The benefits of topical drug delivery include preventing first-pass metabolism, ease of use, avoiding risks associated with intravenous therapy, and achieving continuous drug input for efficacy with a lower total daily dose. However, drawbacks include the potential

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for skin irritation, limitations in the permeation of certain medications, the risk of allergic reactions, denaturation of medications by skin enzymes, and challenges associated with larger particle size medications [14].

Skin diseases, affecting nearly 900 million people globally, are prevalent and include pruritus, acne, eczema, impetigo, Molluscum contagiosum/warts, and scabies. Conditions like atopic dermatitis and acne vulgaris, linked to opportunistic bacteria, require intensive therapy. Acne vulgaris, a common adolescent skin issue, is influenced by hormonal changes and often results in irritation and pustule production. Skin disorders significantly impact patients' quality of life due to emotional and social stigma. Skin microbiota, consisting of commensal bacteria, plays a crucial role in immune responses and defense systems. Imbalances in microbial populations can lead to skin illnesses. Current treatments involve allopathic antibiotics, retinoic acids, and corticosteroids, but these have drawbacks such as antibiotic resistance and side effects. Probiotic and postbiotic-derived bioactives applied topically show promise in treating skin diseases with reduced adverse effects. [15,16] Plant-derived extracts and oils are explored as alternatives due to their non-phytotoxic, antibacterial, and anti-dermatophyte characteristics, offering potential solutions for the pharmaceutical sector. However, there is still much to learn about the causes and functions of the skin microbiome, emphasizing the need for novel therapies.

## 2. Materials and methods

### 2.1. Materials

Pomegranate is obtained from local botanical garden and authenticated from botanist. Liquid Paraffin, Stearic Acid, Bees Wax, Stearyl Alcohol, Tween-80, and Methyl Paraben were purchased from Stride Laboratories Pvt. Ltd, Bangalore.

### 2.2. Extraction

Soxhlet extraction technique is used where finely ground substance was placed within a permeable bag or "thimble" made of cellulose or robust filter paper. The extraction solvent, methanol, was heated in the lower flask, transformed into vapor within the sample thimble, condensed through the condenser, and subsequently collected. This process was reiterated until the liquid reached the siphon arm, flowed back into the lower flask, and, ultimately, the methanolic extract was collected.[17]

### 2.3. Preparation steps

Two methods, the slab method and trituration method, are employed for cream preparation. In the slab method, ingredients are mixed until homogeneity is achieved, either using an cream mill or impromptu compounding. The cream is placed on a slab, stirred in a geometric pattern, and distilled water is added as necessary. This technique is known as the slab or impromptu method [18]. The trituration method is suitable for liquid or finely split insoluble powder particles. Insoluble powder is added through geometric dilution, and liquid is incorporated without creating air pockets. Using a stainless steel spatula, the solid medication is reduced to a fine powder on the cream slab, combining it with a small amount of base until a homogeneous product is formed [19, 20].

The formulation process involves heating the oil and aqueous phases separately, with the aqueous phase consisting of methyl paraben and deionized water, and the oil phase containing pomegranate extract, liquid paraffin, beeswax, stearyl alcohol, Tween-80, and stearic acid. The phases are combined dropwise in a homogenizer, continuously stirred for 15 minutes at 2000 rpm. The speed is then reduced to 1000 rpm for an additional five minutes, followed by another five minutes at 500 rpm. This results in the creation of an herbal skin cream with pomegranate extract [20]. The composition of herbal cream is shown in Table 1.

**Table 1.** Composition of herbal cream

| S.No | Ingredient (%) | F1 | F2 | F3 | F4 | F5 | F6 |
|---|---|---|---|---|---|---|---|
| 1 | Pomegranate extract | 5 | 4 | 3 | 3 | 3 | 4 |
| 2 | Liquid Paraffin | 5 | 5 | 5 | 5 | 5 | 5 |
| 3 | Stearic Acid | 3 | 3 | 5 | 5 | 4 | 5 |
| 4 | Bees Wax | 5 | 6 | 5 | 4 | 6 | 5 |
| 5 | Stearyl Alcohol | 10 | 10 | 10 | 8 | 8 | 7 |
| 6 | Tween-80 | 8 | 5 | 5 | 5 | 5 | 6 |
| 7 | Methyl Paraben | 0.12 | 0.12 | 0.12 | 0.12 | 0.12 | 0.12 |
| 8 | De-ionized Water | 33 | 36 | 37 | 40 | 39 | 38 |

### 2.4. Evaluation of herbal cream

*2.4.1. Physical evaluation*

This includes a visual inspection to assess the formulation's appearance, color, and odor. A meticulous scrutiny of these characteristics is essential to ensure not only the aesthetic appeal but also the overall quality of the formulation. [21]

*2.4.2. Determination of pH*

The pH measurement was conducted utilizing a pH meter, which underwent calibration before each utilization with standard buffer solutions at pH 4, 7, and 9. The electrode was introduced into the sample 10 minutes prior to obtaining the reading at room temperature. [21]

*2.4.3. Spreadability*

Spreadability is assessed by measuring the time, in seconds, it takes for two slides to slide off from the gel when positioned between them under a specific load. An excess of the sample was applied between two glass slides, and a predetermined weight was placed on these slides to compress them uniformly. A weight of 70 g was added, and the duration needed to separate the two slides was recorded. [21] Spreadability was then calculated using the formula

$$S = m \times l/t,$$

where S represents spreadability, m is the weight attached to the upper slide, l denotes the length moved on the glass slide, and t represents the time taken.

*2.4.4. Viscosity*

The formulations' viscosity was assessed using a Brookfield Viscometer (DV-I PRIME, USA). The cream were subjected to rotation at speeds of 0.3, 0.6, and 1.5 rotations per minute. The viscosity of the cream was determined by multiplying the dial reading at each speed by the respective factor provided in the Brookfield Viscometer catalogue. [22]

*2.4.5. Stability*

In the skin irritation study, twenty volunteers were subjected to gel masks with and without tea leaf extract and fenugreek powder, and no significant irritation, including burning, redness, or swelling, was observed. The gel mask formulations were consistent, except for the presence or absence of the mentioned extracts. Application was randomized, and participants were closely monitored for primary and secondary skin reactions. [23]

## 3. Results and Discussion

The results of the formulations (F1 to F6) were evaluated based on various properties, providing insights into their characteristics and stability. In terms of appearance, all formulations (F1 to F6) exhibited a semi-solid consistency, indicating a uniform texture across the different formulations. The characteristic odor observed in all formulations further signifies a consistent olfactory profile, contributing to product recognition and user experience. [4,9]

The color of the formulations was consistently dark red across all samples (F1 to F6), suggesting a deliberate and uniform choice of pigmentation in the formulations. This uniformity in color is crucial for maintaining product aesthetics and meeting consumer expectations. Thermal stability testing at both room temperature and 65% ± 5% relative humidity revealed that formulations F1 to F4 remained stable without any observable separation. However, formulations F5 and F6 exhibited slight oily separation, indicating a potential sensitivity to higher temperatures or humidity in these particular formulations. pH measurements were within a relatively close range for all formulations, ranging from 5.95 to 6.98. This suggests that the formulations are generally near neutral, which is important for compatibility with the skin and maintaining the desired properties of the product. [23] Viscosity measurements provide insights into the flow properties of the formulations. Formulation F1 had the highest viscosity at 3886 cPs, followed closely by F2, F3, F4, F5, and F6. The variation in viscosity among the formulations may influence factors such as ease of application and user experience. The formulations demonstrate overall consistency in appearance, odor, and color. However, differences in thermal stability, pH, and viscosity highlight specific variations that should be considered in the formulation and manufacturing process. Further analysis and adjustments may be necessary, particularly for formulations F5 and F6, to enhance their stability and optimize their overall performance. The results are shown in Table 2.

**Table 2.** Results of evaluation of herbal cream

| S. No | Properties | F1 | F2 | F3 | F4 | F5 | F6 |
|---|---|---|---|---|---|---|---|
| 1 | Appearance | Semi solid | Semi solid | Semi solid | Semi-solid | Semi-solid | Semi solid |
| 2 | Odour | Characteristic | Characteristic | Characteristic | Characteristic | Characteristic | Characteristic |
| 3 | Colour | Dark red | Dark red | Dark red | Dark red | Dark red | Dark red |
| 4 | Thermal Stability (At room temperature and 65% ± 5% RH) | Stable, no separation | Stable, no separation | Stable, no separation | Stable, no separation | Slight oily separation | Slightly oil separation |
| 5 | pH | 6.98 | 5.98 | 6.16 | 6.20 | 5.95 | 5.97 |
| 6 | Viscosity (cPs) | 3886 | 3960 | 3978 | 3467 | 3278 | 3269 |

## 4. Conclusion

The pomegranate cream showcased multifunctional benefits, demonstrating the efficacy of the herbal constituents used. Formulations F1 to F6 exhibited stability at room temperature, affirming their safety for skin application. Notably, F2 asserted superiority over other herbal cream formulations. The study's primary focus lies in exploring the potential of plant extracts for cosmetic use, given the increasing prevalence of cosmetics in personal care. The formulated cream demonstrated consistency, spreadability, and no phase separation throughout the trial. The cream's standout qualities include high nutritional value, minimal chemical content, cost-effectiveness, and a straightforward production process. Acting as a protective barrier for the skin, the herbal cosmetic formulation is deemed safe for use. Test results suggest its topical application for shielding the skin against harm.

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**Author's short biography**

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Arushi had completed her Post graduation in Pharmaceutics. She is currently working as Assistant Professor. She has 8 review and research articles published in reputed peer reviewed journals