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Formulation and evaluation of a polyherbal cream-gel based on medicinal leaf extracts for skin health applications

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Abstract: Topical formulations have been widely used for the treatment of dermatological conditions. This study aims to develop and evaluate a polyherbal cream gel formulation for topical application using leaf extracts of *Calendula officinalis, Hibiscus rosa-sinensis, Bryophyllum pinnatum,* and *Rosa spp*. The formulation was designed to integrate the benefits of cream and hydrogel systems to improve skin hydration, lubricity, and therapeutic efficacy. The cream gel was formulated using Carbopol 940 as a gelling agent with suitable excipients such as glycerine and propylene glycol to improve wetting and penetration. The developed formulation was evaluated for important physicochemical parameters, including texture, smoothness, pH, viscosity, and spreadability. The formulation showed a semi-solid consistency with smooth texture, good uniformity, and viscosity in the range of 500-1000 cps, indicating reasonable rheological behaviour. The diffusion capacity was found to be 11.33 g cm/sec, indicating ease of application, while the pH of 6.56 was within the acceptable range for a topical preparation. Biological evaluation showed significant antioxidant activity and remarkable antimicrobial activity against *Staphylococcus aureus*. The formulation also showed excellent moisturizing properties due to the presence of humectants and hydrophilic polymers. Stability studies confirmed that the formulation remained stable with no changes in physical properties, and irritation testing indicated that it was safe and non-irritating for topical use. Overall, the developed polyherb cream gel demonstrated promising physicochemical and biological properties, indicating its potential application in wound healing, topical drug delivery, and skin care as a natural alternative to synthetic formulations.

Introduction

A large variety of secondary metabolites of plants, including phenols, flavonoids, alkaloids, tannins, and terpenes, are responsible for the medicinal benefits of these plants [1]. These phytochemicals often work together to have therapeutic effects that may exceed a single ingredient [2]. However, several serious problems with traditional herbal preparations, such as decoctions, extracts, and crude pastes, are reported [3]. These problems include poor stability, inconsistent dosing, lack of standardization, and uncontrolled release of active ingredients, which can result in toxicity or subtherapeutic effects [4]. There has been increasing interest in the development of topical formulations that not only treat these conditions but also provide additional benefits such as moisture, antioxidant protection, and improved skin health [5, 6]. Traditional topical formulations, including creams and ointments, have been widely used for the treatment of dermatological conditions [7]. However, these formulations often suffer from limitations such as lubricity, poor dispersibility, low patient

compliance, and limited drug penetration [8]. Cream-gels are hybrid systems that combine the benefits of creams and hydrogels, offering improved stability, drug release, spreadability, and a non-greasy feel [9]. Such formulations are particularly beneficial for managing multifunctional skin conditions that require simultaneous antimicrobial, antioxidant, and moisturizing effects [10, 11].

Extracts of leaves of *the selected Calendula officinalis, Hibiscus rosa-sinensis, Bryophyllum pinnatum,* and *Rosa spp*. were made based on their well-documented medicinal properties. Leaves, compared to other parts of the plant, are a rich source of bioactive compounds such as flavonoids, tannins, phenols, alkaloids, and glycosides, which contribute significantly to their therapeutic potential [12-14]. *Calendula officinalis* is recognized for its wound healing, anti-inflammatory, and antimicrobial properties. The presence of triterpenoids, flavonoids, and carotenoids contributes to its ability to promote tissue regeneration and reduce inflammation [15]. *Hibiscus rosa-sinensis* is known for its antioxidant and moisturizing properties, primarily due to a high content of anthocyanins and phenolic compounds, which help to remove free radicals and maintain the skin's moisture [16]. *Bryophyllum pinnatum* has remarkable antimicrobial and wound healing activities, which are attributed to its rich content of flavonoids [17]. Similarly, *Rosa spp.* is known for their antioxidant, astringent, and soothing properties, making them beneficial for maintaining skin health and preventing oxidative damage [18]. The incorporation of antioxidant-rich herbal extracts in topical formulations can help to neutralize free radicals and protect the skin from oxidative damage. The use of antimicrobial herbal medicines provides a safe alternative to synthetic antibiotics, reducing the risk of resistance and side effects [19, 20]. Humectants such as glycerine and propylene glycol are often used in formulations to increase water retention and improve skin hydration. When mixed with hydrophilic polymers such as Carbopol, these agents contribute to the formation of a stable and effective cream-gel system [21]. Techniques such as phosphomolybdenum assay for antioxidant activity and disc diffusion method for antimicrobial evaluation are widely used for this purpose [22]. The formulation is designed to achieve optimal performance by combining the therapeutic benefits of herbal extracts with the benefits of a cream-gel delivery system [23]. A formulation with an appropriate pH close to the skin is essential to prevent irritation and maintain skin compatibility. Similarly, stability studies are important for assessing a product's durability and reliability under varying conditions [24, 25]. This study aimed to formulate and evaluate a polyherbal cream-gel based on medicinal leaf extracts for skin health applications.

Materials and methods

Collection of the plants: Fresh leaves of *Calendula officinalis, Hibiscus rosa-sinensis, Bryophyllum pinnatum*, *and Rosa spp.* were collected from the herbal garden of Madan Mohan Malaviya University of Technology, a state university in Gorakhpur, Uttar Pradesh, India, in 2025. The collected herbs were identified and verified by the Department of Botany of MMMUT. The collected leaves were washed thoroughly with distilled water to remove dust and foreign matter, then air-dried **(Table 1)**.

Preparation of leaf extracts: The decoction method was used for the extraction of plant components. The collected leaves were shade-dried for seven days to preserve the heat-sensitive components and then ground to a coarse powder using a mechanical grinder. Approximately 25 g of each powdered drug was mixed with 250 ml of distilled water and boiled slowly for 30-45 min until the volume was reduced by half **(Table 2)**. The extract was filtered and concentrated to one-fourth volume using a water bath, then stored in airtight containers for further use [26]. The decoction method makes sure that efficient extraction of the hydrophilic constituents of plants, which is the reason for antioxidant and antimicrobial activities [31].

Method of preparation of polyherbal cream-gel (100 g Batch): Carbopol 940 was dispersed in distilled water with constant stirring and allowed to hydrate completely to form a gel base. The herbal extracts were mixed with glycerine and propylene glycol to ensure uniform dispersion. The methylparaben was dissolved separately and added to the mixture. For the cream stage, wax and liquid paraffin were melted at approximately

70°C. Borax dissolved in hot water was added to the oil phase with continuous stirring to form an emulsification system. The aqueous phase was slowly added to the oil phase at the same temperature to obtain a smooth cream base. The prepared cream base was then slowly incorporated into the hydrated Carbopol gel with continuous stirring to form a cream gel system. The herbal extract mixture was slowly added, followed by pH adjustment using 0.1 N NaOH to achieve a pH range of 6.0-6.8. The final weight was adjusted to 100 g using distilled water and mixed well until a smooth, homogeneous, and lump-free formulation was obtained.

Table 1: Medicinal properties of selected herbal extracts

Extract	Medicinal value	Image	Ref.
Calendula officinalis (Marigold leaf)	Possesses anti-inflammatory, antimicrobial, and wound healing properties; rich in flavonoids and triterpenoids that promote tissue regeneration		[27]
Hibiscus rosa-sinensis (Hibiscus leaf)	Exhibits antioxidant and moisturizing activity; contains anthocyanins and phenolic compounds that help in skin hydration and		[28]
Bryophyllum pinnatum (Patharchatta leaf)	Known for antimicrobial, wound healing, and anti-inflammatory effects, it contains flavonoids and alkaloids that aid in skin repair		[29]
Rosa gallica (Rose leaf)	Provides antioxidant, astringent, and soothing effects; helps in skin toning and hydration		[30]

Table 2: Composition of the polyherbal cream-gel

Ingredient	Quantity	Function
Carbopol 940	1.0 g	Gelling agent: provides viscosity and forms a hydrogel network
Calendula officinalis	3.0 g	Antimicrobial effects and skin hydration properties
Hibiscus rosa-sinensis	3.0 g	Antioxidant and moisturizing agent
Bryophyllum pinnatum	2.0 g	Antimicrobial and healing booster
Rosa gallica	2.0 g	Act as a skin toner and soothing agent
Glycerine	10 g	Humectant: improves skin hydration and moisture retention
Propylene glycol	5.0 g	Co-solvent and penetration enhancer; improves spreadability and absorption
Methyl paraben	0.3 g	Preservative
Beeswax	3.0 g	Thickening agent; provides consistency and stabilizes the cream phase
Liquid paraffin	10 g	Emollient: softens skin and provides an occlusive moisturizing effect
Borax	0.5 g	Emulsifying agent; helps in formation of oil-in-water (O/W) cream base
NaOH (0.1 N)	3.0 ml	Neutralizing agent; adjusts pH and facilitates gel formation
Distilled water	q.s. to 100 g	Vehicle: dissolves ingredients and forms the base of the cream gel

Evaluation of polyherbal cream-gel: The prepared polyherbal cream-gel was evaluated by various physicochemical and *in-vitro* parameters to ensure its quality, stability, efficacy, and suitability for topical use.

Organoleptic properties: The formulation was evaluated visually for colour, appearance, odour, and texture.

Homogeneity and washability: Homogeneity was assessed by visual inspection and touch. Washability was evaluated by applying the formulation on skin and observing ease of removal with water [32].

Stability studies: The formulation was stored at room temperature for 20 days and evaluated at regular intervals for physical appearance, pH, viscosity, and homogeneity [33].

pH determination: A 5.0 g sample of the formulation was dispersed in 50 mL of distilled water, and the pH was measured using a calibrated digital pH meter.

Spreadability: Spreadability was determined by placing 0.1 g of cream-gel between two glass slides under a 100 g weight for 15 sec. It was calculated using the formula: Spreadability = (W × L) / T, where W is weight (g), L is length spread (cm), and T is time in sec [34].

Viscosity Measurement: Viscosity was measured using a Brookfield DV-II+ viscometer with an LV-4 spindle at varying rotational speeds (0.5-20 rpm) [35].

Antioxidant activity: Total antioxidant capacity was determined using the phosphomolybdenum method. The reaction mixture containing extract and reagent solution was incubated at 95°C for 90 minutes, and absorbance was measured at 695 nm using a UV-visible spectrophotometer. Results were expressed as ascorbic acid equivalents [36].

Irritancy test: The formulation was applied to a marked area on the dorsal surface of the skin and observed for erythema, oedema, or irritation over 2 hours [37].

Antimicrobial activity: Antibacterial activity was evaluated using the disc diffusion method against *Staphylococcus aureus* on Mueller-Hinton agar medium. Plates were incubated at 37°C for 24 hrs., and the zone of inhibition was measured in millimetres. Minimum inhibitory concentration (MIC) was determined by the serial dilution method [38, 39].

Skin hydration study: Hydration capacity was evaluated using a water retention method, where the ability of the formulation to retain moisture over time was assessed [40].

Results

Organoleptic properties: Data on the organoleptic properties are presented in **Table 3**.

Table 3: The organoleptic properties of the polyherbal cream-gel

Organoleptic evaluations	Results
Colour	White/light brown
Appearance	Smooth, semi-solid
Odour	Characteristic herbal odor
Texture	Absence of lumps

pH determination: The pH of the formulation was found to be 6.56 ± 0.2, which lies within the normal skin pH range (5.5-6.5). This suggests that the formulation is skin-compatible and unlikely to irritate upon application.

Viscosity: The viscosity of the cream-gel ranged between 500 and 1000 cps, indicating suitable rheological behaviour. This range ensures ease of application, adequate retention on the skin surface, and controlled release of active constituents.

Spreadability: The spreadability value was calculated as 11.33 g·cm/sec, demonstrating that the formulation spreads easily with minimal shear, ensuring uniform application on the skin.

Skin hydration activity: The formulation exhibited good moisture retention capacity due to the presence of a hydrophilic polymer network (Carbopol), along with humectants such as glycerine and propylene glycol. Herbal components like Hibiscus and Rose extracts further contributed to the moisturizing effect.

Antioxidant activity: The antioxidant capacity of the formulation was evaluated using the phosphomolybdenum method. The formulation exhibited significant antioxidant activity, as indicated by its absorbance value and ascorbic acid equivalent content **(Table 4)**.

Table 4: Assessment of antioxidant activity of the polyherbal cream-gel

Sample	Absorbance at 695 nm	Total antioxidant capacity (µg AAE/mL)
Blank (Methanol)	0.000	—
Standard (Ascorbic acid)	0.850 ± 0.02	—
Polyherbal cream-gel	0.620 ± 0.03	72.94 ± 2.0

Stability studies: The formulation remained stable throughout the study period, with no observable changes in colour, phase separation, pH, or consistency. These indicate good physical stability and acceptable shelf-life.

Antimicrobial activity: The cream-gel demonstrated significant antibacterial activity against *Staphylococcus aureus*, as evidenced by clear zones of inhibition. The activity increased with concentration, indicating a dose-dependent response **(Figure 1** and **Table 5)**.

Skin irritation test: No signs of erythema, oedema, or irritation were observed at the site of application, confirming that the formulation is non-irritant and safe for topical use. The summary of the evaluation, including all parameters, is mentioned in **Table 6**.

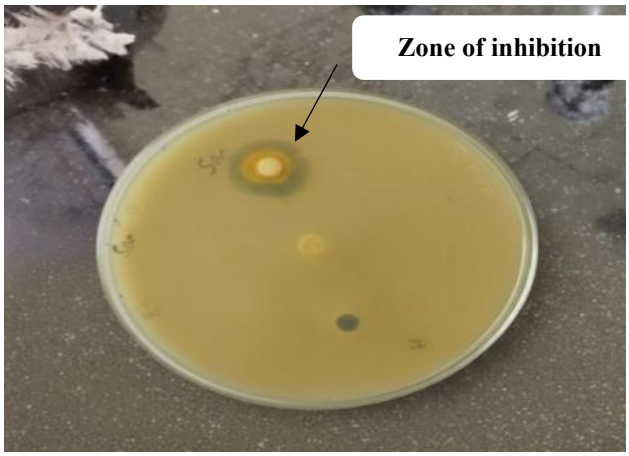

Figure 2: Antimicrobial evaluation of the polyherbal cream-gel

Table 5: Composition of media for antimicrobial evaluation of the polyherbal cream-gel

Material	Quantity
Agar	1.4 g
Beef extract	0.4 g
Sodium chloride	0.5 g
Peptone	0.4 g
Distilled water	100 ml

Table 6: Summary of evaluation parameters for the polyherbal cream-gel

Parameters	Observations
Texture	Smooth
State of formulation	Semi-solid
Viscosity	500-1000 cp
Anti-microbial evaluation	Good
Stability Studies	Stable
Antioxidant activity	Have antioxidant activity
Skin hydration	Retain hydration
Spreadability	11.33 g·cm/sec
pH test	6.56
Irritancy test	Non- irritant to skin
Homogeneity test	Good

Discussion

The cream gel had a smooth, semi-solid consistency, ideal for topical application. The even texture and good uniformity ensure even distribution of active components, thereby improving therapeutic effect and patient compliance. The viscosity of the formulation was observed to be in the range of 500-1000 cps, indicating optimum stability. The range is easy to apply and ensures the formulation remains on the skin surface for a sufficient period without becoming too runny or too hard. Balanced viscosity also contributes to the controlled release of active components [41]. The spreadability value of 11.33 g·cm/sec suggests that the formulation can be easily spread on the skin with minimal effort. Good spreadability is a critical parameter as it ensures uniform application and better coverage of the affected area [42]. The pH of the formulation (6.56) was found to be within the acceptable range for skin applications (5.5-7.0), indicating that the cream-gel is compatible with the natural skin pH and is unlikely to cause irritation or disrupt the skin barrier [43]. The antimicrobial activity of the formulation was reported to be good, confirming its effectiveness against microbial strains [44]. This activity can be attributed to the presence of bioactive phytoconstituents such as flavonoids, tannins, and phenolic compounds in the leaf extract, which are known to have antimicrobial properties. Likewise, the formulation showed significant antioxidant activity, which plays an important role in neutralizing free radicals and protecting the skin from oxidative stress. This property enhances the effectiveness of the formulation in wound healing and skin protection [45, 46]. Skin hydration studies have shown that the formulation retains moisture effectively, which can be attributed to the presence of humectants such as glycerine and propylene glycol, along with hydrophilic polymers (Carbopol) [47]. Irritation test results indicate that the formulation is non-irritating, as no signs of erythema or oedema were observed. This confirms the safety and biocompatibility of the formulation for topical use [48]. The polyherbal cream-gel is stable, effective, and suitable for topical use with antimicrobial, antioxidant, and moisturizing properties.

Conclusion: The developed polyherbal cream-gel formulation demonstrated excellent physicochemical stability, significant antimicrobial and antioxidant activities, and effective skin hydration properties. The formulation was found to be non-irritating, stable, and suitable for topical application. These findings suggest that the polyherbal cream-gel has strong potential as a natural alternative for topical drug delivery, wound healing, and skincare applications.

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