

Formulation and Evaluation of Phyto-Bioactive Topical Spray for the Management of Infective Dermal Pathologies

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Abstract: *Infective dermatitis is a common dermatological disorder characterized by inflammation, itching, erythema, microbial infection, and skin barrier disruption. Conventional topical therapies such as corticosteroids, antibiotics, and antifungal agents provide symptomatic relief but are frequently associated with adverse effects including skin irritation, hypersensitivity, microbial resistance, and recurrence after long-term use. Herbal medicine has gained significant attention as an alternative therapeutic approach due to its safety, biocompatibility, affordability, and broad-spectrum pharmacological activities. Medicinal plants rich in phytoconstituents such as flavonoids, tannins, alkaloids, terpenoids, glycosides, and polyphenols exhibit antimicrobial, anti-inflammatory, antioxidant, wound-healing, and immunomodulatory effects beneficial for skin disorders.*

*The present review focuses on the development and evaluation of a phyto-bioactive topical herbal spray formulated using Neem (*Azadirachta indica*), Turmeric (*Curcuma longa*), Aloe vera (*Aloe barbadensis* Miller), *Calendula officinalis*, and Sandalwood (*Santalum album*). The pharmacological significance of these medicinal plants, phytochemical constituents, extraction procedures, formulation development, evaluation parameters, antimicrobial activity, and future perspectives are comprehensively discussed. The developed formulation demonstrated satisfactory physicochemical properties, skin-compatible pH, excellent homogeneity, good sprayability, acceptable stability, and significant antifungal activity against pathogenic microorganisms. The synergistic combination of medicinal plant extracts in topical spray dosage form offers an innovative, patient-compliant, and effective approach for the management of infective dermatitis and related skin infections..*

Keywords: Infective dermatitis, herbal spray, phytochemicals, Neem, Turmeric, Aloe vera, *Calendula officinalis*, antimicrobial activity, topical drug delivery

I. INTRODUCTION

Skin acts as the first line of defense against environmental pathogens, toxic chemicals, allergens, and physical injury. Dermatological disorders are among the most common health problems worldwide and significantly affect quality of life. Infective dermatitis is a chronic or recurrent inflammatory skin condition associated with bacterial, fungal, or mixed microbial infections. It commonly presents with itching, redness, swelling, burning sensation, scaling, lesions, and exudation [1].

The prevalence of infective skin disorders has increased considerably due to poor hygiene, environmental pollution, increased microbial resistance, immunosuppression, and excessive use of synthetic chemicals. Conventional treatments include antibiotics, antifungal agents, corticosteroids, and antiseptics. Although effective, prolonged use of these agents



may result in adverse effects such as skin thinning, irritation, hypersensitivity, microbial resistance, and recurrence of infection [2].

Herbal medicine has been used for centuries in the treatment of wounds, skin infections, burns, ulcers, and inflammatory disorders. Medicinal plants contain diverse phytochemicals capable of exerting multiple pharmacological effects simultaneously. Herbal topical formulations are increasingly preferred because they are safer, economical, biodegradable, eco-friendly, and therapeutically effective [3].

Topical sprays represent an advanced drug delivery system that ensures easy application, uniform distribution, reduced contamination risk, rapid drying, and enhanced patient compliance. A phyto-bioactive topical spray incorporating antimicrobial and wound-healing herbs can provide synergistic therapeutic action for infective dermatitis [4].

II. INFECTIVE DERMATITIS

2.1 Definition

Infective dermatitis is an inflammatory dermatological condition associated with microbial infection involving bacteria, fungi, or viruses. It causes damage to the epidermal barrier and leads to irritation and secondary infections.

2.2 Etiology

The major etiological factors include:

- Bacterial infection
- Fungal infection
- Viral infection
- Allergic reactions
- Poor personal hygiene
- Excess sweating
- Skin trauma
- Immunological disorders
- Environmental pollutants

2.3 Pathophysiology

In infective dermatitis, microbial invasion causes activation of inflammatory mediators including histamine, cytokines, prostaglandins, and interleukins. These mediators induce redness, itching, swelling, and tissue injury. Persistent inflammation damages the skin barrier, allowing further microbial colonization and chronic infection [5].

2.4 Clinical Manifestations

Common symptoms include:

- Erythema
- Itching
- Burning sensation
- Pain
- Cracking of skin
- Vesicles
- Pustules
- Scaling
- Oozing lesions
- Secondary infection



III. CONVENTIONAL TREATMENT AND LIMITATIONS

The commonly used conventional therapies include:

- Topical corticosteroids
- Antifungal agents
- Antibiotics
- Antihistamines
- Antiseptic creams
- Immunosuppressive agents

Despite effectiveness, these therapies possess several limitations:

- Skin irritation
- Allergic reactions
- Antibiotic resistance
- Fungal resistance
- Skin atrophy
- Recurrence after discontinuation
- Systemic toxicity on prolonged use

These limitations have encouraged exploration of safer herbal alternatives [6].

IV. HERBAL MEDICINE IN DERMATOLOGY

Medicinal plants have become increasingly important in dermatological therapy because of their broad pharmacological activities and minimal side effects. Herbal drugs contain secondary metabolites that provide therapeutic benefits against skin disorders.

Advantages of Herbal Formulations

- Natural origin
- Reduced toxicity
- Better patient acceptance
- Biocompatibility
- Cost effectiveness
- Eco-friendly nature
- Multiple pharmacological activities
- Reduced resistance development
- Herbal topical formulations provide antimicrobial, anti-inflammatory, antioxidant, wound-healing, and soothing effects simultaneously [7].

V. TOPICAL HERBAL SPRAY DRUG DELIVERY SYSTEM

Topical sprays are liquid preparations designed for external application using a spray pump mechanism. These systems distribute the formulation evenly over affected skin areas.

Advantages of Topical Sprays

- Uniform drug distribution
- Non-greasy nature
- Rapid drying
- Easy administration
- Touchless application



- Reduced risk of contamination
- Improved patient compliance
- Better aesthetic appeal

Herbal sprays are especially useful in infective dermatitis because they minimize direct contact with infected skin and provide rapid therapeutic action [8].

VI. MEDICINAL PLANTS USED IN HERBAL SPRAY FORMULATION

6.1 Neem (Azadirachtaindica)

Neem belongs to the family Meliaceae and is widely recognized for its medicinal properties. The plant contains bioactive compounds including azadirachtin, nimbin, nimbidin, quercetin, flavonoids, tannins, alkaloids, and phenolics [9].

Pharmacological Activities of Neem

Antibacterial Activity

Neem inhibits bacterial growth by damaging microbial cell membranes and interfering with metabolic processes.

Antifungal Activity

Neem extract shows significant activity against *Candida albicans*, *Aspergillusniger*, and dermatophytes.

Anti-inflammatory Activity

Neem suppresses inflammatory mediators and reduces redness and swelling.

Wound-Healing Activity

Neem accelerates collagen synthesis and tissue regeneration.

Antioxidant Activity

Phenolic compounds present in Neem scavenge free radicals and reduce oxidative stress [10].

Phytochemical Constituents

- Flavonoids
- Alkaloids
- Phenolics
- Tannins
- Glycosides

6.2 Turmeric (Curcuma longa)

Turmeric belongs to the family Zingiberaceae and is one of the most extensively studied medicinal plants. Curcumin is the principal active constituent responsible for most therapeutic activities [11].

Pharmacological Activities of Turmeric

Anti-inflammatory Activity

Curcumin inhibits cyclooxygenase, lipoxygenase, and inflammatory cytokines.

Antioxidant Activity

Curcumin neutralizes reactive oxygen species and protects tissues from oxidative damage.

Antimicrobial Activity

Turmeric inhibits bacterial and fungal pathogens associated with skin infections.

Wound-Healing Activity

Curcumin enhances collagen deposition and epithelial regeneration.

Antiseptic Activity

Turmeric prevents microbial contamination of wounds and lesions [12].

Phytochemical Constituents

- Curcumin



- Demethoxycurcumin
- Bisdemethoxycurcumin
- Tannins
- Flavonoids
- Phenolics

6.3 Aloe vera (Aloe barbadensis Miller)

Aloe vera belongs to the family Asphodelaceae and is highly valued for its soothing and moisturizing properties.

Bioactive Constituents

- Aloin
- Aloe-emodin
- Acemannan
- Polysaccharides
- Vitamins
- Amino acids
- Enzymes
- Minerals

Pharmacological Activities

Moisturizing Activity

Aloe vera hydrates the skin and prevents dryness.

Wound-Healing Activity

It stimulates fibroblast proliferation and collagen synthesis.

Anti-inflammatory Activity

Aloe vera reduces irritation and swelling.

Antimicrobial Activity

It exhibits antibacterial and antifungal activity against skin pathogens.

Skin Soothing Activity

Provides cooling effect and relief from itching and burning sensation [13].

6.4 Calendula officinalis

Calendula officinalis belongs to the family Asteraceae and possesses remarkable wound-healing properties.

Pharmacological Activities

Wound-Healing Activity

Calendula stimulates granulation tissue formation and epithelialization.

Anti-inflammatory Activity

Flavonoids and triterpenoids inhibit inflammatory responses.

Antimicrobial Activity

Calendula inhibits microbial growth responsible for skin infection.

Antioxidant Activity

It protects tissues from oxidative injury [14].

Phytochemical Constituents

- Triterpenoids
- Flavonoids
- Tannins



- Alkaloids
- Cardiac glycosides

6.5 Sandalwood (*Santalum album*)

Sandalwood is an aromatic medicinal plant containing alpha-santalol and beta-santalol.

Pharmacological Activities

- Antimicrobial activity
- Anti-inflammatory activity
- Cooling effect
- Skin soothing activity
- Antioxidant activity
- Sandalwood reduces itching, irritation, and burning associated with dermatitis [15].

VII. ROLE OF EXCIPIENTS

7.1 Glycerine

Glycerine acts as a humectant and moisturizer.

Functions

- Maintains skin hydration
- Prevents dryness
- Enhances smoothness
- Improves product consistency

7.2 Rose Water

Rose water acts as a soothing and refreshing agent.

Functions

- Skin toning
- Anti-inflammatory activity
- Mild antimicrobial effect
- Cooling sensation

7.3 Sodium Benzoate

Sodium benzoate is used as a preservative.

Functions

- Prevents microbial contamination
- Improves shelf life
- Maintains formulation stability

VIII. EXTRACTION OF HERBAL MATERIALS

Aqueous extraction was employed for preparation of herbal extracts.

Neem Extract

- Neem powder: 25 g
- Distilled water: 250 mL

The mixture was heated for 30 minutes, cooled, and filtered.

Turmeric Extract

- Turmeric powder: 25 g



- Distilled water: 250 mL

The extract was prepared by heating and filtration.

Calendula Extract

Calendula petals were boiled in distilled water and filtered.

Aloe vera Extract

Aloe vera powder was heated in distilled water, cooled, and filtered to obtain clear extract [16].

IX. FORMULATION DEVELOPMENT

Composition of Herbal Spray

Ingredients	Quantity	Role
Neem extract	3.0 mL	Antibacterial
Turmeric extract	2.5 mL	Anti-inflammatory
Calendula extract	5.0 mL	Wound healing
Aloe vera extract	3.0 mL	Soothing
Glycerine	1.0 mL	Humectant
Sodium benzoate	0.1 g	Preservative
Tween 20	1.0 mL	Foaming agent
Rose water	q.s. to 20 mL	Vehicle

Method of Preparation

- Herbal extracts were mixed uniformly.
- Glycerine was added gradually.
- Sodium benzoate dissolved in rose water was incorporated.
- Tween 20 was added with continuous stirring.
- Final volume was adjusted using rose water.
- The formulation was filtered.
- Final product was filled into sterile spray bottles [17].

X. EVALUATION PARAMETERS

10.1 Physical Evaluation

The formulation showed:

- Orange-brown color
- Clear homogeneous appearance
- Smooth texture
- Pleasant sandalwood odor

10.2 pH Determination

The pH was found to be 5.40, which is compatible with the physiological pH of skin.

10.3 Spray Pattern Test

The spray produced a uniform circular pattern with an area of 12.56 cm² indicating satisfactory sprayability.

10.4 Evaporation Time

The evaporation time was 420 seconds, indicating rapid drying and non-greasy behavior.

10.5 Homogeneity Test

Microscopic examination confirmed uniform distribution without particle aggregation.

10.6 Stability Study

The formulation remained stable without precipitation, phase separation, or significant changes in odor and color.



10.7 Skin Irritation Study

No redness, irritation, itching, or edema was observed upon application.

XI. PHYTOCHEMICAL SCREENING

Phytochemical studies confirmed the presence of therapeutically active compounds.

Neem

- Phenolics
- Flavonoids
- Alkaloids
- Carbohydrates

Turmeric

- Curcumin
- Tannins
- Flavonoids
- Phenolics

Aloe vera

- Anthraquinones
- Saponins
- Flavonoids
- Phenolics

Calendula officinalis

- Triterpenoids
- Flavonoids
- Alkaloids
- Cardiac glycosides
- Tannins [18]

XII. ANTIMICROBIAL ACTIVITY

The antimicrobial activity was evaluated using agar well diffusion method.

Against *Aspergillusniger*

Sample	Zone of Inhibition
Test sample	27 mm
Clotrimazole	32 mm

Against *Candida albicans*

Sample	Zone of Inhibition
Test sample	24 mm
Clotrimazole	25 mm

The results demonstrated strong antifungal activity of the herbal spray [19].

XIII. FUTURE PROSPECTS

Future studies may focus on:

- HPLC standardization
- HPTLC fingerprinting
- In vivo wound-healing studies
- Clinical evaluation



- Accelerated stability studies
- Toxicity profiling
- Nano-herbal spray systems
- Large-scale industrial production

XIV. CONCLUSION

The present review highlights the therapeutic potential of a phyto-bioactive topical herbal spray for the treatment of infective dermatitis. The synergistic combination of Neem, Turmeric, Aloe vera, Calendula officinalis, and Sandalwood provides broad-spectrum antimicrobial, anti-inflammatory, antioxidant, soothing, and wound-healing activities. The developed herbal formulation demonstrated satisfactory physicochemical properties, excellent homogeneity, skin-compatible pH, rapid drying, stability, and significant antifungal efficacy. Herbal topical sprays therefore represent a promising, safe, economical, and patient-friendly alternative to synthetic dermatological therapies.

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