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Research Article

Development of a Polyherbal Emulgel of *Centella asiatica* and Pipernigrum: A Novel Approach for Wound Management

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ABSTRACT

Wound healing is a complex process that may be delayed by microbial infection, Wound inflammation, oxidative stress, and increasing antimicrobial resistance. Centella asiatica (L.) Urban, traditionally known as Mandookaparni in Ayurveda, has long been used for wound management and skin disorders. Its major triterpenoid phytoconstituents, including asiaticoside, madecassoside, Asiatic acid, and madecassic acid, contribute to wound repair through stimulation of collagen synthesis, fibroblast proliferation, angiogenesis, re-epithelialization, and modulation of inflammation. Piper nigrum contains piperine, its principal alkaloid, which possesses reported antibacterial, anti-inflammatory, and antibiofilm properties. The present study aims to develop and optimize a topical herbal emulgel containing extracts of C. asiatica and P. nigrum for potential wound management. The extracts will be prepared using suitable extraction techniques and evaluated for relevant phytoconstituents, followed by incorporation into an emulgel using appropriate oil-phase components, surfactants, and gelling agents. Formulations will be optimized by evaluating appearance, homogeneity, pH, spreadability, viscosity, extract/marker content, and stability. The optimized formulation will be evaluated for antimicrobial activity against selected wound-associated microorganisms and, where feasible, in-vitro wound-healing potential.

INTRODUCTION

Currently available for wound care, but the management of chronic wounds remains challenging because of their complex nature. Which created a need for newer therapeutic approaches that can address the different factors involved in delayed or impaired wound healing[3].Nowadays, medical experts have presented considerable interest in plant-based drugs as they are recognized as safe, low-cost and more suitable for chronic wounds[4,5].

An innovative approach is needed to address the limitations of the previously mentioned topical dosage forms, such as utilizing an emulgel—a gel-based emulsion[6].

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Table 1: Mechanism Based Chart of Centellaasiatica Healing Mechanism

Mechanism/effect	Major constituents	Mechanism of healing	References
Collagen synthesis	Aciaticoside, madecassoside.	Promotes collagen formation, particularly type 1 and 3 collagen, supporting extracellul-ar matrix formation and tissue repair.	[13]
TGF-ß/Smad pathway	Asiaticoside, Madecassoside.	Modulates TGF-ß/sm-ad signalling,promoti-ng fibroblast activity and collagen synthesi-s.	[13]
Fibroblast proliferation	Asiaticoside, madecassoside.	Stimulates fibroblast activity,contributing to collagen formation and wound healing contraction.	[13]
Re-epithelialization	C.asiatica extract,tri - terpenes.	Supports keratinocyte migration and regeneration of the epidermal layer.	[12]
Angiogenesis	Asiaticoside and other triterpenes.	Promote new blood vessel formation, improving oxygen and nu-trient supply for healing tissue.	[11]

Centella asiatica and it's constituents Centella asiatica belongs to family Apiaceae. It is also known as Gotu kola Mandookaparni which is mentioned in the Ayurveda (Sushruta Samhita)[7].C. asiatica contains a variety of important bioactive compounds, particularly triterpenoid saponin and their aglycones. The major triterpene

indocentelloside[8]. The primary phytochemical which contributes in pharmacological activity are asiaticoside, asiatic acid , madecassoside, and madecassic acid[8'9]. Several studies have reported that different extracts of Centella asiatica, (TECA, ethanolic and methanolic extracts), may help in the management of various skin conditions and promote wound healing. These extracts and compounds have been investigated for their potential in healing skin wounds, burn injuries, eczema,

excoriations and scars such as hypertrophic and keloid scars[9'10].Various mechanism of wound healing of centella asiatica cons. are mantioned in table[1].

Piper nigrum and Its Pharmacological Importance

Piper nigrum L., commonly known as black pepper, belongs to the family Piperaceae. It is an important medicinal plant that has been traditionally used in various systems of medicine. The fruits of P. nigrum contain several biologically active constituents, including alkaloids, volatile oils, flavonoids, phenolic compounds, and terpenoids. piperine is considered the principal pungent alkaloid and one of the most extensively studied bioactive compounds of black pepper[14'15].

Antimicrobial Activity of Piperine

Microbial infection is an important factor that can delay wound healing, particularly in chronic and contaminated wounds. Therefore, the investigation of natural compounds with antimicrobial properties has attracted considerable interest in pharmaceutical research.

Piperine has demonstrated antimicrobial activity against several microorganisms in experimental studies. Its antibacterial effects have been investigated against organisms including Staphylococcus aureus, Escherichia coli, Pseudomonas aeruginosa, and certain Mycobacterium species. Studies have suggested that piperine may interfere with bacterial membrane functions, affect microbial virulence, influence biofilm-associated processes, and inhibit certain bacterial efflux mechanisms. These activities may contribute to its ability to suppress microbial growth[16'17].

Combination of centella asiatica with piper nigrum

The combination of Piper nigrum and Centella asiatica has attracted interest because of the complementary pharmacological properties of their bioactive constituents. Centella asiatica is rich in triterpenoid compounds, particularly asiaticoside, madecassoside and asiatic acid, which have been associated with different processes involved in wound repair. Piperine, the major pungent alkaloid of Piper nigrum, possesses antioxidant and anti-inflammatory properties and has also been extensively investigated as a natural bioenhancer. Experimental evidence supports the potential wound-healing benefits of this combination. Patel et al. reported that a combination of methanolic extracts of C. asiatica and P. nigrum produced greater antioxidant activity than C. asiatica extract alone. The EC50 values of the combination were reduced by 41.5%, 7.28% and 43.42% in nitric oxide, superoxide and DPPH radical-scavenging assays, respectively, compared with C. asiatica alone[18].



Fig 1:- Piper nigrum extraction using soxhlet apparatus



Fig 2:- Centella asiatica aqueous extract

Formulations

Ingredients	F0 (Blank)	F1	F2	F3
Piper nigrum extract	—	100 mg	100 mg	100 mg
Centella asiatica aqueous extract	—	10 mL	10 mL	10 mL
Eucalyptus oil	5 mL	5 mL	5 mL	5 mL
Tween 80	2.66 g	2.66 g	2.66 g	2.66 g
Span 80	2.34 g	2.34 g	2.34 g	2.34 g
Glycerine	5 mL	5 mL	5 mL	5 mL
Methyl paraben	0.20 g	0.20 g	0.20 g	0.20 g
Carbopol 940	1.0 g (1%)	1.0 g (1%)	0.75 g (0.75%)	1.5 g (1.5%)
Triethanolamine (TEA)	q.s.	q.s.	q.s.	q.s.
Purified water	q.s. to 100 mL	q.s. to 100 mL	q.s. to 100 mL	q.s. to 100 mL

RESULTS:-



Fig 3:- Centrifugation Day 1, No Phase Separation



Fig 4:- Centrifugation after Day 7

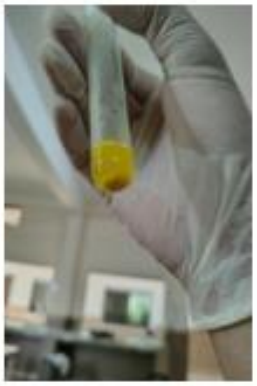


Fig 9:- Mayer Test for piperine



Fig 10:- Hager Test for piperine – Yellow PPT is formed



Fig 5:- Spreadability Test



Fig 6:- Viscosity Test Using Brookfield Viscometer



Fig11:- Solkowaski Test for triterpenoids in centilla asiatica



Fig 12:- Solkowaski Test for triterpenoids in centilla asiatica



Fig 7:- Foam Test for centella asiatica saponin containing A & B



Fig 8:- Dragendroff Test for piperine



Fig 13:- Microscopic Image of cuticle with methylene blue



Fig 14:- Carbopol 940 gelling base pH

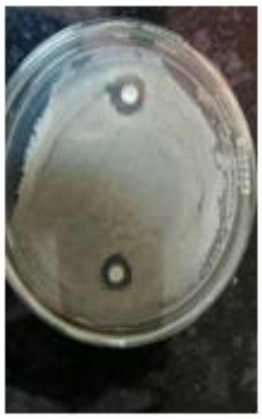


Fig 15:- Antimicrobial Test Report



Fig 16:- Antimicrobial Test Report



ANTIMICROBIAL SUSCEPTIBILITY TEST REPORT

This is to certify that the sample submitted by the students of the School of Pharmaceutical Sciences and Research, Sardar Patel University, Balaghat, was tested for its antibacterial activity against *Staphylococcus aureus*.

The sample demonstrated susceptibility/inhibitory activity against *Staphylococcus aureus* under the laboratory conditions employed.

Note: This report presents laboratory-based experimental results obtained under specified test conditions. They are intended solely for academic and research purposes and must not be used for clinical trials, clinical diagnosis, or therapeutic purposes.

Sample ID: S1
Date of Testing: 21/09/2026
Test Method: Disc Diffusion Method
Zone of Inhibition: 13.6 mm

BIOSPARK BALAGHAT

Authorized Signatory
Biospark Research Institute, Balaghat

Figure 17: Antimicrobial Susceptibility Test Report

CONCLUSION:-

Wound healing is a complex process that may be delayed by microbial infection, inflammation, oxidative stress, and increasing antimicrobial resistance. Centella asiatica (L.) Urban, traditionally known as Mandookaparni in Ayurveda, has long been used for wound management and skin disorders. Its major triterpenoid phytoconstituents, including asiaticoside, madecassoside, Asiatic acid, and madecassic acid, contribute to wound repair through stimulation of collagen synthesis, fibroblast proliferation, angiogenesis, re-epithelialization, and modulation of inflammation. Piper nigrum contains piperine, its principal alkaloid, which possesses reported antibacterial, anti-inflammatory, and antibiofilm properties. Piperine has demonstrated activity against important wound-associated pathogens such as S. aureus and P. aeruginosa, with studies also indicating potential activity against certain multidrug-resistant bacterial strains and bacterial resistance mechanisms. Therefore, combining C. asiatica and P. nigrum may provide complementary wound-healing and

antimicrobial benefits. The present study aims to develop and optimize a topical herbal emulgel containing extracts of C. asiatica and P. nigrum for potential wound management. The extracts will be prepared using suitable extraction techniques and evaluated for relevant phytoconstituents, followed by incorporation into an emulgel using appropriate oil-phase components, surfactants, and gelling agents. Formulations will be optimized by evaluating appearance, homogeneity, pH, spreadability, viscosity, extract/marker content, and stability. The optimized formulation will be evaluated for antimicrobial activity against selected wound-associated microorganisms and, where feasible, in-vitro wound-healing potential. The developed C. asiatica–P. nigrum emulgel may offer a promising plant-based approach for supporting the management of infected and difficult-to-heal wounds, particularly where antimicrobial resistance presents a therapeutic challenge.

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