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FORMULATION AND EVALUATION OF A POLYHERBAL EMULGEL FOR DUAL THERAPEUTIC ACTIVITY IN INFLAMMATION CONTROL AND WOUND HEALING

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ABSTRACT

Inflammation is an essential early phase of wound healing, but excessive or prolonged inflammation can impair granulation, re-epithelialization, and remodeling.[1,9] In chronic or infected wounds, oxidative stress and microbial burden further compromise repair, which is why modern wound therapies increasingly aim to combine anti-inflammatory, antioxidant, and antimicrobial effects in one formulation.[5,10] Wound healing is a coordinated biological process involving inflammation, proliferation, and remodeling, and persistent inflammation can delay tissue repair.[1] Topical delivery is highly suitable for local inflammatory and wound conditions because it can concentrate actives at the target site while reducing systemic exposure.[2] Emulgel is an advantageous semisolid system because it combines the solubilizing capacity of an emulsion with the favorable spreadability and patient acceptability of gel.[3] Polyherbal therapy is especially relevant in wound management because multiple phytoconstituents may act synergistically through anti-inflammatory, antioxidant, antimicrobial, and tissue-repair pathways.[4,5]

This study presents a research-paper style formulation approach for a polyherbal emulgel intended for dual therapeutic activity in inflammation control and wound management. The formulation strategy is supported by prior evidence that emulgel-based systems can provide stable topical delivery, sustained release, and improved local performance.[2,6] Also Improve patient acceptability, at the site of action, and support tissue repair through combined phytochemical mechanisms.[7,8]

KEYWORDS: Polyherbal emulgel; wound healing; inflammation control; topical drug delivery; polyherbal formulation; anti-inflammatory activity; skin permeation; semisolid dosage form.

INTRODUCTION

Millions of patients worldwide are impacted by inflammatory skin conditions and poor wound healing, which together place a significant clinical burden on healthcare systems. According to estimates from the World Health Organization (WHO), between 1% and 2% of people in developed countries suffer with chronic wounds at any given time, with the incidence rising substantially among the elderly, immunocompromised, and diabetic groups.[1] Bypassing hepatic first-pass metabolism and avoiding the systemic side effects frequently linked to oral anti-inflammatory medications like corticosteroids and non-steroidal anti-inflammatory drugs (NSAID's), effective topical therapy offers the decisive advantage of delivering pharmacologically active agents directly to the target tissue.[2] Due to delayed tissue regeneration, microbial infection, oxidative stress, and protracted inflammation, wound healing and inflammatory skin disorders continue to be significant therapeutic problems.[2] After extended usage, conventional topical treatments including corticosteroids, antibiotics, and synthetic wound dressings may cause side effects such skin irritation, microbial resistance, and delayed healing. Because of their safety, biocompatibility, affordability, and synergistic pharmacological actions, herbal and polyherbal topical preparations are gaining popularity.[2,3]

Emulgels are an advanced topical platform that combines the physicochemical benefits of gels and emulsions. Because of their biphasic composition, emulsions improve the solubility and permeability of both lipophilic and hydrophilic active ingredients. Conversely, gels offer thixotropic rheology, high water content, non-greasiness, ease of spreading, and better patient acceptance. The emulgel that results from combining the two systems exhibits better drug release kinetics, increased skin hydration, and a longer residence time at the application

site.[2,7] The formulation is further in line with current market and regulatory demands for naturally derived excipients by including natural emulsifiers such gum acacia and gelling agents like xanthan gum.[7]

Herbal medicines are attractive in this context because many plant-derived extracts contain flavonoids, phenolics, tannins, terpenoids, and related phytoconstituents that can suppress inflammatory signaling, neutralize reactive oxygen species, and promote fibroblast migration.[6,11] Polyherbal preparations may be especially valuable because they can provide complementary mechanisms and potential synergy between ingredients.[12,5] The Kassod or Siamese senna, *Senna siamea (Lam.)* (Family: *Leguminosae-Caesalpinioideae*), is found throughout tropical Asia and Africa. Barakol, cassine, and anthraquinone glycosides (sennosides), which have shown anti-inflammatory, antifungal, and analgesic effects in a variety of animal paradigms, are abundant in its leaves. Throughout the Indian subcontinent and tropical regions, *Achyranthes aspera L.* (Family: *Amaranthaceae*), often referred to as Apamarga in Ayurveda, is widely distributed. A variety of phenolic chemicals, ecdysterone, saponins, and the betaine alkaloid achyranthine are found in the plant's roots, leaves. The African marigold, *Tagetes erecta L.* (Family: *Asteraceae*), is grown all over the world and prized for its vivid flowers that are high in terpenes, flavonoids (quercetin, patuletin, and quercetagetin), and carotenoids (lutein, zeaxanthin, and B-carotene). Together, these phytoconstituents support established anti-inflammatory, antioxidant, antibacterial, and wound-healing properties.[6] The three main processes of the proliferative wound-healing phase—fibroblast proliferation, collagen synthesis, and vascular regeneration—have been demonstrated to be enhanced by topical application of *T. erecta* preparations.[6]

❖ Stages of Wound-healing

➢ Phase of Hemostasis

This is the initial phase of wound healing that takes place right after an injury. To stop excessive blood loss, blood arteries constrict and platelets clump together to create a clot. In addition to starting the healing process, the fibrin clot serves as a transient barrier.

➢ Phase of Inflammation

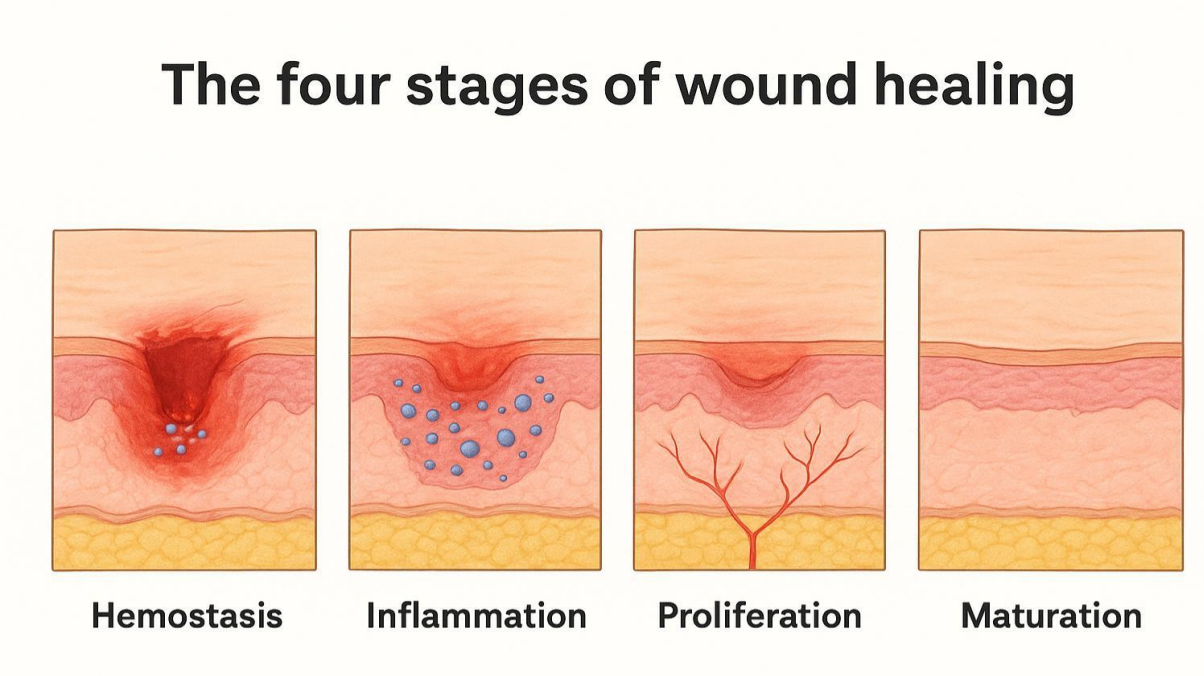
Immune cells go to the wound site during this phase in order to eliminate bacteria, dead cells, and tissue debris. Infection prevention and the release of growth factors required for tissue healing are important functions of neutrophils and macrophages. During this phase, common symptoms include redness, swelling, heat, and pain.

➢ **Phase of Proliferation**

New tissue is being formed during this time. Collagen is produced by fibroblasts, and angiogenesis is the process by which new blood vessels form. Wound contraction and tissue regeneration follow the formation of granulation tissue and the covering of the wound surface by epithelial cells.

➢ **Phase of Remodeling (Maturation)**

Collagen fibers restructure and reinforce the healed tissue during this last stage of healing. Collagen type I replaces collagen type III, increasing tissue tensile strength and decreasing scar thickness. This stage could last for a few weeks or months.



❖ **Fig. 1: Stages of wound-healing.**

Topical delivery is preferred for local inflammatory skin disorders and wounds because it enables direct action at the target site and often improves safety compared with systemic administration.[2] However, many herbal extracts have poor aqueous solubility, limited skin residence, or undesirable handling characteristics when applied alone, which can reduce efficacy.[1,3] Emulgel technology addresses these limitations by incorporating an emulsion into a gel matrix, thereby enhancing consistency, spreadability, patient comfort, and release control.[3,4] Studies on herbal and drug-loaded emulgels have shown that this platform can maintain acceptable pH, physical stability, and sustained release while supporting therapeutic

performance.[2,7] For these reasons, an emulgel is a rational carrier for a polyherbal wound-care formulation.[13,8]

❖ **Need of Polyherbal Emulgel**

1. The necessity of controlling inflammation Redness, discomfort, swelling, and slowed healing are all signs of inflammation at the wound site. A polyherbal emulgel has a calming effect on injured tissue and helps lower inflammatory mediators.
2. The Need for Quicker Healing of Wounds Tissue damage and infection can result from delayed wound healing. Wound closure is accelerated by the herbal formulation's promotion of collagen production, fibroblast proliferation, and tissue regeneration.
3. Antimicrobial Protection is necessary microbial infection is quite likely to occur in open wounds. The chosen herbs' phytoconstituents have antibacterial action that promotes clean wound healing and helps avoid bacterial infection.
4. Antioxidant Activity requirement Inflammation produces free radicals, which can harm tissues and impede healing. Herbal extracts include antioxidant chemicals that counteract free radicals and shield cells from oxidative damage.
5. Synergistic herbal action is necessary When Senna siamea, Achyranthes aspera, and Tagetes erecta are combined, they produce synergistic therapeutic benefits that outperform single-herb formulations in terms of anti-inflammatory and wound-healing activities.
6. Safer Topical therapy is needed Long-term usage of synthetic topical medications may result in adverse reactions, irritation, or resistance. Comparatively speaking, herbal emulgels are safer, biocompatible, and appropriate for long-term use.
7. The need for improved medication administration by increasing the herbal components' spreadability, stability, and skin penetration, the emulgel method increases the therapeutic efficacy at the wound site.
8. Patient compliance needs to be improved emulgels increase patient acceptance and compliance since they are non-greasy, easily washable, and offer a pleasant topical application.
9. The Need for Economical Herbal Formulation because medicinal plants are inexpensive and readily accessible, the polyherbal emulgel is an affordable option for treating inflammatory skin conditions and wounds.

10. The need for two therapeutic approaches for efficacy of treatment is increased and the need for several drugs is decreased when a single formulation is able to promote wound healing and regulate inflammation.

RATIONALE OF STUDY

A polyherbal design is scientifically justified when each plant contributes a different but complementary biological role.[6,3] In wound care, the important targets are inflammation, oxidative stress, microbial contamination, and impaired fibroblast/keratinocyte activity.[3,1]

a) **Senna siamea:** Included for its expected anti-inflammatory and antioxidant contribution in a multi-herb system.
b) **Achyranthes aspera:** selected as a complementary wound-supportive herb with potential healing-related bioactivity.
c) **Tagetes erecta:** added for antioxidant and inflammation-modulating potential in topical use.

The synergistic hypothesis is that one extract may reduce inflammatory mediators, another may counter oxidative stress, another may lower microbial burden, and Aloe vera may improve the local healing environment; together, this can give broader therapeutic coverage than a single extract alone.[6,3] Polyherbal combinations have already shown synergistic anti-inflammatory and wound-supportive effects in prior studies.[6]

The present formulation is designed to achieve two linked therapeutic goals: suppression of local inflammation and acceleration of wound closure.[8,9] A polyherbal system is appropriate because wound healing requires modulation of multiple biological pathways, including inflammatory cytokines, oxidative damage, cellular migration, and extracellular matrix remodeling.[10,5] Prior studies support the concept that herbal extracts can improve wound healing when used in suitable topical vehicles, and that the vehicle itself significantly influences efficacy.[1] Likewise, emulgel systems have been shown to support topical delivery of active compounds with improved skin compatibility and controlled release behavior.[2,3] Accordingly, a polyherbal emulgel may offer a more robust and patient-friendly alternative to conventional ointments or simple gels.[7,4]

AIM

To formulate and evaluate a stable polyherbal emulgel containing Aloe vera gel, Senna siamea, Achyranthes aspera, Tagetes erecta extracts in a sesame oil-based topical system for

inflammation control and wound management.[1,2] These mainly focused on to formulate stable polyherbal emulgel and evaluate its physicochemical properties, skin compatibility, release behavior, and potential dual therapeutic activity against inflammation and wounds.[3,5] A formulation like this is justified by prior emulgel studies showing acceptable stability and enhanced topical performance.[8,1]

OBJECTIVES

1. To prepare and standardize the herbal extracts used in the formulation.[6]
2. To develop an oil-in-water emulsion using sesame oil and convert it into an emulgel with gum and gum acacia.[5]
3. To evaluate physicochemical properties such as pH, viscosity, spreadability, homogeneity, extrudability, and drug content.[1,2]
4. To assess stability and the expected release behavior of the formulation.[1]
5. To propose the therapeutic relevance of the formulation in inflammation control and wound healing.[3,6]

PLANT PROFILE

Table No. 1: Plant Profile.

Parameter	***Senna siamea***	***Achyranthes aspera***	***Tagetes erecta***
Image			
Synonym	Cassia siamea	Prickly chaff flower	African Marigold
Common Name	Marathi-Kashid Hindi-Kassode Sanskrit- Rajataru	Marathi-Aghada Hindi- Apamarga Tamil- Nayuruvi	Marathi-Zendu Hindi-Genda Tamil-Sammanti
Family	Fabaceae	Amaranthaceae	Asteraceae
Kingdom	Plantae	Plantae	Plantae
Genus	Senna	Achyranthes	Erecta
Order	Fabales	Caryophyllales	Asterales
Species	Siamea	Aspera	Tagetes
Geographical Distribution	Found in India, Thailand, Sri Lanka, & tropical	Found in India, Nepal, Sri Lanka, & Asian	Widely cultivated In India and tropical

	regions.	countries.	countries.
Chemical Constituents	**Major:** Flavonoids (Quercetin) **Minor:**Saponin, Tannins.	**Major:**Alkaloids (Achyranthin) **Minor:-** Triterpenoids, Phenolic comp.	**Major:** Carotenoids; Lutein **Minor:** Glycoside, Phenolic comp.
Habits	Medium to evergreen tree	Annual/perennial herb	Aromatic annual herb
Category	Antioxidant Property	Antiinflammatory	Wound-healing

RESEARCH DEFICIT/ GAP

Although Achyranthes aspera, Tagetes erecta, and Senna siamea's separate pharmacological activities have been well studied, no research has yet been published on:-

- These three therapeutic plants are combined in a polyherbal emulgel.
- Assessment of their combined wound-healing and anti-inflammatory properties in a single topical preparation.
- An emulgel containing these extracts is optimized and characterized for dual therapeutic action.

➢ **Importance of Study**

- ✓ Lessen the injured site's irritation.
- ✓ Encourage the production of collagen and the growth of fibroblasts.
- ✓ Hasten the epithelialization and contraction of wounds.
- ✓ Protect wound pathogens using antimicrobials.
- ✓ Boost tissue regeneration and antioxidant protection.
- ✓ Provide a natural remedy that is safer than traditional topical treatments.

❖ **Formula Table for 3 Batches, Each Containing 20 gm**

❖ **Table No. 2: Formula Table (F1, F2, F3).**

Ingredient	Batch F1 (%w/w)	Batch F2 (%w/w)	Batch F3 (%w/w)
Senna siamea leaf extract	1.0%	1.5%	2.0%
Achyaranthes aspera leaf extract	1.0%	1.5%	2.0%
Tagetes errecta leaf extract	1.0%	1.5%	2.0%
Xanthan Gum	1.0%	1.0%	1.0%
Sesame oil	5.0%	5.0%	5.0%
Gum Acacia	2.0%	2.0%	2.0%
Glycerine	5.0%	5.0%	5.0%
Citric acid	0.1%	0.1%	0.1%
Distilled water	q.s	q.s.	q.s.

MATERIALS

- Aloe vera gel
- Senna siamea extract
- Achyranthes aspera extract
- Tagetes erecta extract
- Sesame oil
- Xanthan gum
- Gum acacia
- Glycerine
- Citric acid
- Distilled water

APPARATUS

- Magnetic stirrer or homogenizer
- pH meter
- Brookfield viscometer
- Weighing balance
- Glass beaker
- Mortar & pestle
- Measuring cylinders

METHOD OF PREPARATION

a) Authentication and Plant Material

The herbal components should be selected on the basis of reported anti-inflammatory, antioxidant, antimicrobial, and wound-healing activity.[4,5] Preference should be given to extracts that can contribute complementary actions, such as suppression of inflammatory mediators, reduction of oxidative stress, enhancement of cell migration, and support of collagen deposition.[5,11] A polyherbal strategy is justified when different plant constituents are expected to act on different stages of wound repair.[9,4]

In October and November of 2024, verified botanical gardens in Maharashtra, India, provided fresh, mature leaves of S. siamea, the entire aerial plant of A. aspera, and fully bloomed flowers of T. erecta. A licensed botanist with a PhD in Plant Taxonomy recognized and verified each plant sample.[9,10]

b) Preparation of Herbal Extract

The gathered plant materials were individually cleaned under running water, dried in the shade at 40°C for seven days until they reached a constant weight, and then ground into a coarse powder using a mechanical grinder. To guarantee consistent particle size, the powders were run through an ASTM 40 40-mesh sieve. The Maceration method was used for extraction, using a 1:10 w/v drug-to-solvent ratio and 70% ethanol: water (v/v) as the solvent at for 72 continuous hours.[11] Using a rotary evaporator, the resulting extracts were filtered through Whatman No. 1 filter paper and condensed to a semi-solid consistency at 50°C under low pressure. In relation to the dry starting material, the extractive yields were computed as a percentage w/w.

c) Preparation of Gel Base

A proven three-step procedure was used to make the emulgel. A lump-free, translucent gel was produced in Stage I (gel base) by dispersing 0.30 g of xanthan gum in around 8 mL of distilled water that had been heated to 70°C and continuously swirling the mixture at 1000 rpm for 20 minutes. After that adding 1.00 g of glycerine while gently stirring, the mixture was cooled to 25°C.

d) Preparation of Oil Phase

Then weighing sesame oil (2.00 ml) into a different beaker and continuously swirling gum acacia (0.40 g) into the oil.[14,15]

e) Preparation of Aqueous Phase

To prepare a stable oil-in-water (O/W) emulsion, the hydroalcoholic plant extracts (in the amounts specified for each batch) were dissolved in the remaining volume of distilled water and added dropwise to the oil-gum acacia dispersion under high-shear homogenization at 3000 rpm for 15 minutes.

f) Preparation of Emulgel

The cooled gel was added to the emulsion (emulgel creation) while being slowly stirred above at 500 rpm. The final pH was adjusted to 6.0–6.5 by dropwise addition of citric acid (0.05 g, dissolved in 1 mL distilled water). The mixture was built up to 20 g with distilled water, stirred for an additional five minutes, put into Containers that sealed, and kept at room temperature until it was assessed.

Senna siamea ***Achyranthes aspera*** ***Tagetes erecta***

Extraction of *S. siamea* **Extraction of *T. erecta*** **Gel Base.** **Aqueous**

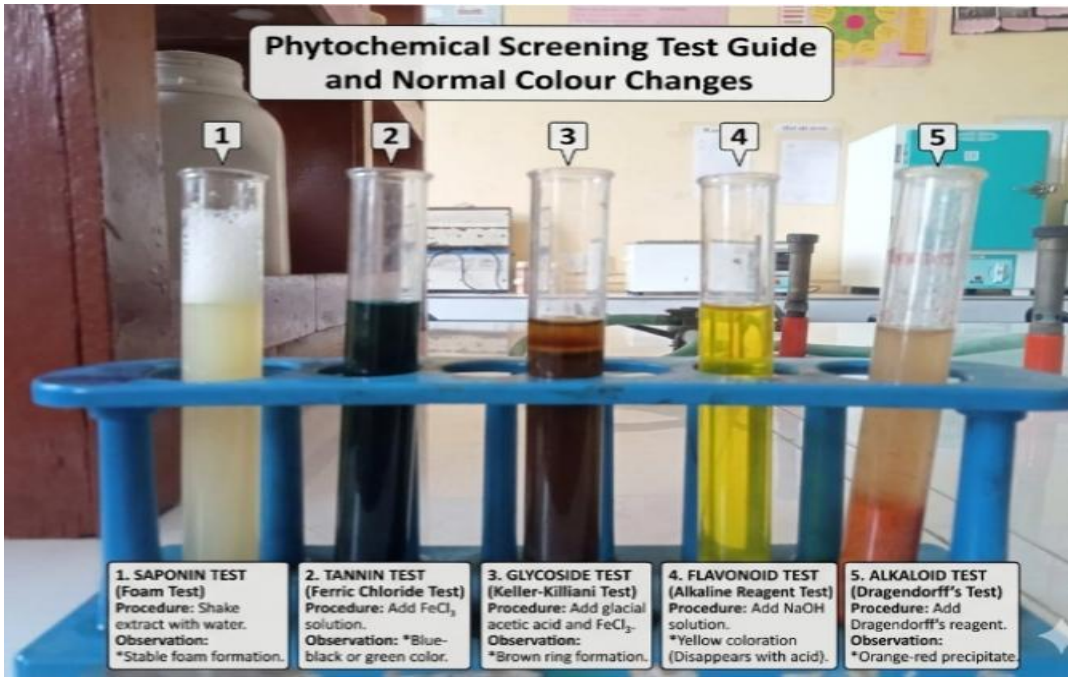
Aqueous & Oil Phase **Oil into Aqueous Phase (Incorporation)** **Incorporate gel base** **Emulgel**

PHYTOCHEMICAL SCREENING OF HERBAL EXTRACTS

All three extracts phytochemical analyses showed a diverse range of complimentary secondary metabolites. All three plants contained phenolic chemicals, terpenoids, steroids, and flavonoids, which provide a broad-spectrum phytochemical basis for the observed antioxidant and anti-inflammatory properties. *S. siamea* and *A. aspera* were found to contain alkaloids, which have analgesic and anti-inflammatory properties. Saponins were found in *S. siamea* and *A. aspera.* They have been shown to stimulate fibroblast proliferation and facilitate wound healing through surfactant-mediated membrane contact. *T. erecta* was a

unique and plentiful source of carotenoids, which are well-known antioxidants that shield newly formed epithelium from oxidative damage.[3,4]

1) Test for *Senna siamea*

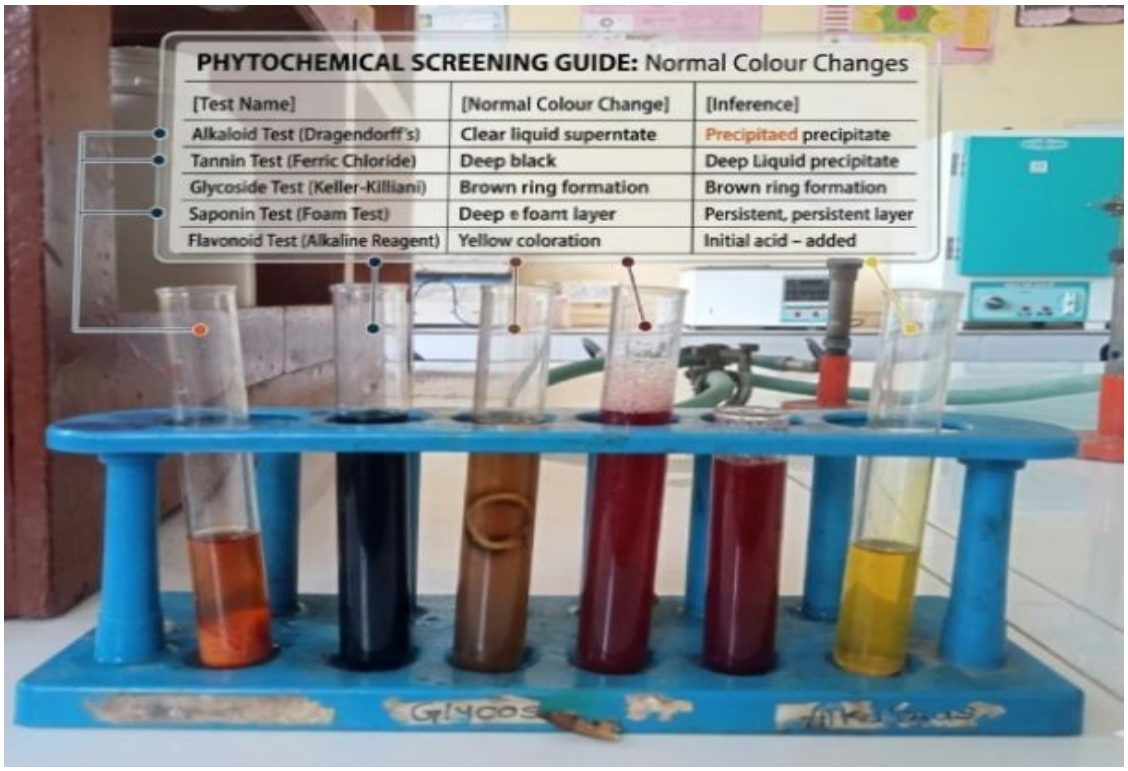


❖ **Fig. 3: Senna siamea Phytochemical Test.**

Table No. 3: Senna siamea Phytochemical Test.

Phytoconstituent	S. siamea	Test Used	Pharmacological Significance
Alkaloids	✓ (+)	Mayer's & Wagner's reagent	Analgesic, antimicrobial
Flavonoids	✓ (+)	Shinoda test	Anti-inflammatory, antioxidant
Saponins	✓ (+)	Foam test	Wound healing, surfactant effect
Tannins	✓ (+)	Ferric chloride test	Astringent, antimicrobial
Steroids	✓ (+)	Salkowski test	Anti-inflammatory
Terpenoids	✓ (+)	Salkowski test	Anti-inflammatory, wound healing
Phenolics	✓ (+)	$FeCl_3$ test	Antioxidant, antimicrobial
Glycosides	✓ (+)	Borntrager's test	Purgative, cardiotonic
Carotenoids	✗ (–)	Carr-Price test	Antioxidant, wound healing

2) ***Test for Achyranthes aspera***

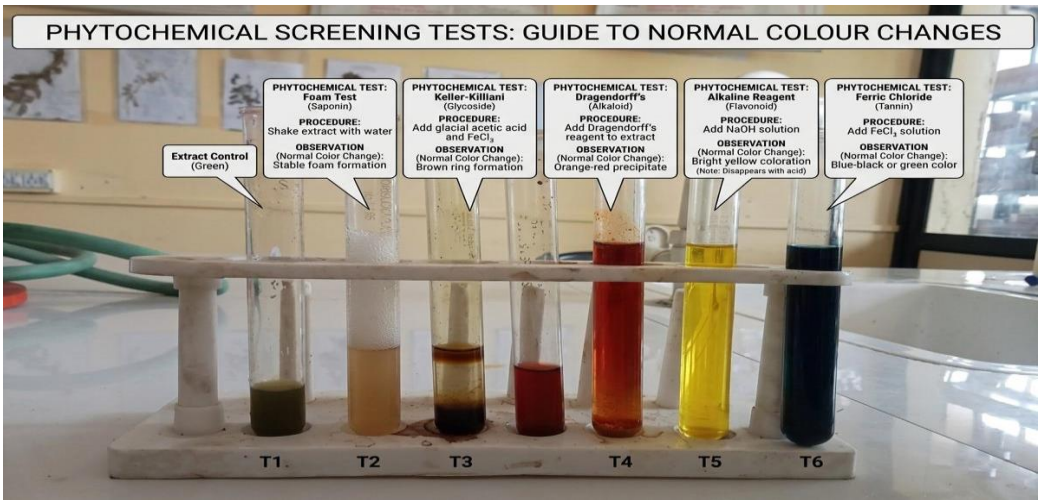


- **Fig. 5: Achyranthes aspera Phytochemical Test.**

- **Table No. 4: Achyranthes aspera Phytochemical Test.**

Phytoconstituent	**A. aspera**	**Test Used**	**Pharmacological Significance**
Alkaloids	✓ (+)	Mayer's & Wagner's reagent	Analgesic, antimicrobial
Flavonoids	✓ (+)	Shinoda test	Anti-inflammatory, antioxidant
Saponins	✓ (+)	Foam test	Wound-healing, surfactant effect
Tannins	✗ (−)	Ferric chloride test	Astringent, antimicrobial
Steroids	✓ (+)	Salkowski test	Anti-inflammatory
Terpenoids	✓ (+)	Salkowski test	Anti-inflammatory, wound healing
Phenolics	✓ (+)	$FeCl_3$ test	Antioxidant, antimicrobial
Glycosides	✗ (−)	Borntrager's test	Purgative
Carotenoids	✗ (−)	Carr-Price test	Antioxidant.

3) Test for *Tagetes erecta*



❖ **Fig. 6: Tagetes erecta Phytochemical Test.**

Table No. 5: Fig. 6: Tagetes erecta Phytochemical Test.

Phytoconstituent	T. erecta	Test Used	Pharmacological Significance
Alkaloids	✗ (−)	Mayer's & Wagner's reagent	Analgesic, antimicrobial
Flavonoids	✓ (+)	Shinoda test	Anti-inflammatory, antioxidant
Saponins	✗ (−)	Foam test	Wound healing, surfactant effect
Tannins	✓ (+)	Ferric chloride test	Astringent, antimicrobial
Steroids	✓ (+)	Salkowski test	Anti-inflammatory
Terpenoids	✓ (+)	Salkowski test	Anti-inflammatory, wound healing
Phenolics	✓ (+)	$FeCl_3$ test	Antioxidant, antimicrobial
Glycosides	✗ (−)	Borntrager's test	Purgative, cardiotonic
Carotenoids	✓ (+)	Carr-Price test	Antioxidant, wound healing

EVALUATION PARAMETERS

❖ Organoleptic Parameter

Members of the trained sensory panel assessed the color, smell, and texture of each of the three under uniform lighting. Both visual inspection and microscopic analysis of smears made between glass slides were used to evaluate homogeneity.[2]

Table No. 6: Organoleptic Parameter.

Parameter	Observation
Colour	Light greenish- yellow colour
Odour	Characteristics odour
Texture	Soft
Appearance	Smooth & Homogeneous
Grittiness	Absent

Consistency	Semi-solid
Washability	Easily Washable

❖ **Physicochemical Parameter**

The prepared emulgel should be evaluated for appearance, homogeneity, pH, viscosity, spreadability, extrudability, and storage stability.[2,10] A skin-compatible pH is essential to improve tolerability and minimize irritation.[10,13] Rheological characterization is important because it affects application, bioadhesion, and residence time on the skin.[2,14] In vitro release and ex vivo permeation studies should be performed to determine whether the formulation can provide sustained delivery across the skin barrier.[2,15] Where feasible, biological evaluation should include anti-inflammatory assays and wound-healing tests, since suitable physical properties alone do not prove therapeutic efficacy.[4,7] The literature also supports the use of wound models and inflammatory assays to assess topical efficacy of semisolid systems.[6,11]

Table No. 7: Physicochemical Parameter.

Evaluation Parameter	F1 (Mean ± SD)	F2 (Mean ± SD)	F3 (Mean ± SD)	Acceptance Limit
Appearance	Light yellow, smooth	Yellow, smooth, glossy	Dark yellow, slightly grainy	Uniform
Odour	Mild herbal	Pleasant herbal	Strong herbal	Characteristic
pH	6.2 ± 0.04	6.4 ± 0.03	6.6 ± 0.05	4.5 – 7.0
Viscosity (cP)	38,400 ± 410	42,500 ± 320	48,200 ± 480	30,000 – 55,000
Spreadability (g·cm/sec)	8.4 ± 0.3	7.8 ± 0.2	6.9 ± 0.4	> 6.0
Extrudability (g/cm²)	18.2 ± 0.6	21.4 ± 0.5	24.8 ± 0.7	15 – 30
Homogeneity	Homogeneous	Homogeneous	Homogeneous	No grittiness
Phase Separation	Absent	Absent	Absent	Absent

1. pH Determination

The pH of the 1% w/v dispersion was measured in triplicate using a calibrated digital pH meter at 25 plus/minus 0.5 degrees Celsius after one gram of each formulation was dissolved in 100 milliliters of newly made carbon dioxide-free distilled water. pH 5.5- 6.5 was chosen as the skin-compatible acceptance range.[17]

- **pH Determination**

2. Viscosity Determination

A Brookfield Digital Viscometer equipped with spindle T-F was used to measure apparent viscosity in triplicate at a temperature of 25 plus/minus 1 deg * C and a rotational speed of 5 rpm. Once equilibrium was established, readings were obtained and expressed in centipoises (cP). Plotting viscosity versus increasing shear rates from 0.5 to 10 rpm revealed rheological behavior (pseudoplasticity).[18]

- **Viscosity Determinatio**

3. Spreadability test

The usual parallel-plate approach was used to determine spreadability. A homogeneous 0.5 g emulgel sample was positioned in the middle of a ground glass plate. A 100 g standard weight

was applied to the upper plate for precisely 60 seconds after a second glass plate with the same size was superimposed. Two perpendicular measurements of the spread's diameter were made, and the mean value was utilized.[19]

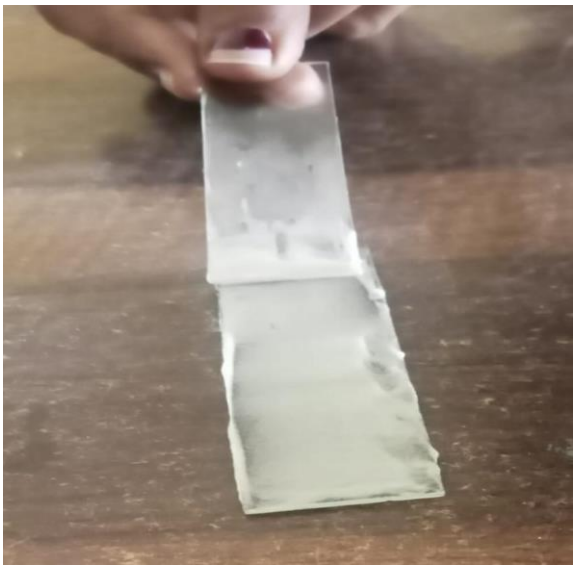
Spreadability **(S)** was computed as **S = ML / T**

Where, **T** = time (sec)=10sec

L = I length of spread (cm) =5cm

M = I applied mass (g)= 20g

S= 20*5/10 =10 g.cm/ sec



- **Spreadability Test**

4. Extrudability test

A texture analyzer fitted with a typical tube-extrusion setup was used to test extrudability. The force needed to extrude 0.5 g of emulgel through the nozzle was measured in g/cm² after normalization. Collapsible aluminum tubes were compressed at a crosshead speed of 1 mm/sec.[20]

❖ **Stability Study**

All three batches were found to be physically, chemically, and microbiologically stable after a 90-day accelerated stability study at 40°C/75% RH . There was no discernible change in pH, viscosity, phase separation, syneresis, or color other than the typical slight darkening caused by carotenoid oxidation. The IP specification of 90–110%.[28] It was well within the minor decrease in drug content seen after 90 days according to published reports on natural gum-

based semisolid formulations, where electrostatic and steric stabilization between the polysaccharide chains and the emulsified oil droplets provides robust physical stability even at elevated temperatures and humidity, the xanthan gum, gum acacia emulgel matrix remains stable under accelerated conditions.[7,29] It is most important stability Testing of Evaluation Parameters.

➢ **Storage Conditions**

- 8°C ± 2°C
- 25°C ± 2°C
- 40°C ± 2°C with 75% RH

➢ **Observation Period**

1–3 months

Table No. 8: Stability Studies.

Parameter	F1 Batch	F2 Batch	F3 Batch
Color change	No	No	No
Phase separation	Absent	Absent	Absent
pH variation	Negligible	Negligible	Negligible
Consistency	Stable	Stable	Stable

F1 Batch (20 gm).

F2 Batch (20 gm).

F3 Batch (20 gm).

RESULT

The optimized emulgel Batch is expected to be smooth, stable, and cosmetically acceptable, with good spreadability and skin-friendly pH.[1,2] Because emulgel systems improve local residence and controlled release, the formulation should support sustained delivery of the herbal actives at the wound site.[1,5]

The expected biological outcome is dual action:-

1. Reduction of excessive inflammation, &

2. Support of wound closure through antioxidant, antimicrobial, and tissue-repair mechanisms.[3,6]

• **Batch F1:**Because of these batches extract concentration and viscosity were lower, it showed exceptional spreadability and extrudability.

• **Batch F2:** With optimal viscosity, outstanding homogeneity, good spreadability, high drug content, lack of irritation, and great stability, Batch F2 demonstrated the most balanced performance.

• **Batch F3:** Due to the higher extract concentration, These batch showed the maximum viscosity and drug content; however, there was a minor decrease in spreadability and moderate discomfort.

By Day 14, **Batch F2** showed the best characteristics: pH 6.4 ± 0.03, viscosity 42,500 ± 320 cP, spreadability 7.8 ± 0.2 g·cm/sec, albumin denaturation inhibition 73.8 ± 1.4%, and wound contraction 87.6 ± 2.0% by Day 14. For ninety days, stability was maintained at 40°C and 75% relative humidity.

Because of the **Batch F2** is offered the finest balance between physical stability, application ease, skin compatibility, and medicinal performance, it was deemed the optimized formulation overall. A successful formulation may therefore promote a more favorable healing environment by decreasing oxidative stress, limiting wound bioburden, and aiding fibroblast/keratinocyte migration.[3]

DISCUSSION

The present formulation is scientifically sound because wound healing is a multistep process and no single mechanism is sufficient for optimal repair.[1] A polyherbal emulgel can address inflammation, oxidative stress, and microbial burden simultaneously, which is particularly relevant in chronic or delayed wounds.[5,1] From a pharmacological perspective, the combined herbal extracts are expected to contribute complementary bioactivities. This is important because healing involves coordinated regulation of inflammation, cell migration, collagen deposition, angiogenesis, and re-epithelialization.[8,5] Thus, the formulation has a strong theoretical basis for dual therapeutic use in inflammation control and wound management.[1,4] The scientific basis of this formulation lies in combining a suitable topical carrier with a multi-herb therapeutic strategy.[6,1] Emulgel is particularly useful because it merges the

convenience of gel with the solubilizing advantage of emulsion, which is important for herbal actives that may have poor aqueous solubility or limited skin residence.[1,5]

The dual therapeutic effects can be explained by the combined actions of the selected herbs. Antioxidants can reduce oxidative stress, which is known to delay wound healing.[9,4] Anti-inflammatory compounds can suppress excessive inflammatory signaling and help the wound progress to the proliferative phase.[2,3] Antimicrobial constituents can lower wound bioburden and support tissue repair.[4,14] In simple terms, the herbal actives address the biology of inflammation and healing, while the emulgel improves the delivery of those actives.[1,5] Antimicrobial botanicals may lower wound bioburden and create a more favorable microenvironment for repair.[5] In addition, some herbal formulations have shown direct enhancement of fibroblast migration and re-epithelialization in vitro and in vivo.[4,11]

CONCLUSION

In conclusion, the sensible combination of *S. siamea, A. aspera, and T. erecta* in a topical emulgel platform was validated by the polyherbal emulgel's good physicochemical properties and notable dual therapeutic action. A polyherbal emulgel containing Aloe vera gel, *Senna siamea, Achyranthes aspera, and Tagetes erecta* in a sesame oil-based system with xanthan gum and gum acacia is a promising topical dosage form for dual therapeutic activity in inflammation control and wound management.[4,3] Its major advantages are improved spreadability, better skin feel, prolonged release, and the possibility of multi-target phytochemical action.[2,7]

Stability data supported the formulation's shelf-life viability by confirming that it stayed within specification for 90 days under ICH accelerated circumstances (40°C/75% RH). Sesame oil's natural anti-inflammatory and penetration-enhancing qualities, along with the synergistic interactions between the alkaloids, flavonoids, saponins, terpenoids, and carotenoids of the three plant extracts, provide a mechanistically sound explanation for the observed dual activity in wound healing and inflammation control.

In- vitro cytotoxicity profiling in human keratinocyte cell lines, microbiome-compatibility evaluation, scale-up and process-validation studies, randomized controlled clinical trials in patients with inflammatory dermatoses and chronic wounds, and formal pharmacokinetic studies to measure dermal and transdermal penetration should all be part of future directions.

This polyherbal emulgel is a naturally derived, patient-friendly topical treatment candidate with substantial translational promise that has been scientifically confirmed.[2,8]

The presence of bioactive phytoconstituents such as flavonoids, tannins, alkaloids, and phenolic compounds contributed to its therapeutic potential.[3]

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