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Evaluation of Herbal Formulation for the Treatment of Acne

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Abstract: *Acne vulgaris is one of the most common chronic inflammatory skin disorders affecting adolescents and young adults worldwide. It occurs due to multiple factors such as excessive sebum production, bacterial colonization, follicular hyper keratinization and inflammation.*

Conventional treatments including antibiotics, retinoids, and hormonal therapies are widely used for acne management; however, prolonged use of these therapies may produce adverse effects such as skin irritation, dryness, microbial resistance, and recurrence of lesions. Therefore, there is an increasing demand for safer, effective, and natural alternatives for acne treatment.

The present study focuses on the design, development, and evaluation of a herbal formulation intended for the treatment of acne. Herbal ingredients possessing antimicrobial, anti-inflammatory, antioxidant, and wound-healing properties were selected based on traditional medicinal use and literature review.

The formulation was prepared using natural extracts such as neem, turmeric, aloe vera, Tulsi, and tea tree oil, which are well known for their therapeutic activity against acne-causing microorganisms and skin inflammation.

The developed herbal formulation was subjected to various evaluation parameters including physical appearance, pH, viscosity, spread ability, homogeneity, washability, stability studies, and antimicrobial activity.

The formulation showed satisfactory physicochemical characteristics with good consistency, acceptable pH suitable for skin application, and enhanced spread ability. Stability studies indicated that the formulation remained stable under different storage conditions without significant changes in color, odor, texture, or phase separation. Antimicrobial studies demonstrated effective inhibitory activity against acne-causing bacteria, confirming the therapeutic potential of herbal preparation.

The study concludes that the developed herbal formulation can serve as a safe, economical, and effective alternative for the management of acne vulgaris. The use of herbal ingredients minimizes the risk of side effects associated with synthetic drugs while providing significant therapeutic benefits. This research supports the growing importance of herbal cosmetics and natural dermatological preparations in modern healthcare and highlights the potential of plant-based formulations in acne treatment.

Keywords: Anti Acne, herbal gel, Neem, Turmeric, Alovera, Ashwaganda

I. INTRODUCTION

1.1 Introduction to Acne

Acne vulgaris is one of the most common chronic inflammatory disorders affecting millions of people worldwide, especially adolescents and young adults. It is a disease of the pilosebaceous unit, which includes hair follicles and sebaceous glands present mainly on the face, chest, shoulders, and upper back. Acne is characterized by the appearance of comedowns (blackheads and whiteheads), papules, pustules, nodules, and cysts. In severe cases, acne may lead to permanent scaring and psychological distress.

The development of acne involves multiple factors such as excessive sebum production, blockage of hair follicles due to hyper keratinization, bacterial colonization by Cuti bacterium acnes (formerly Propionibacterium acnes), and inflammatory reactions. Hormonal changes during puberty are considered one of the primary causes of acne because

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they stimulate sebaceous glands to produce more sebum. Genetic predisposition, stress, poor dietary habits, environmental pollution, cosmetic products, and certain medications also contribute to acne formation.

Although acne is not a life-threatening disease, it significantly affects the emotional and social well-being of individuals. Many patients experience anxiety, depression, reduced self- confidence, and social withdrawal due to facial lesions and scarring. Therefore, effective management of acne is essential not only for skin health but also for improving quality of life. (1,2)

1.2 Structure and Physiology of Skin

The skin is the largest organ of the human body and serves as a protective barrier against physical, chemical, and microbial damage. It consists of three main layers:

1. Epidermis

The epidermis is the outermost layer responsible for protection and prevention of water loss. It contains keratinocytes, melanocytes, and immune cells.

2. Dermis

The dermis lies beneath the epidermis and contains connective tissue, blood vessels, nerves, sebaceous glands, sweat glands, and hair follicles.

3. Hypodermis

The hypodermis is the deepest layer composed mainly of adipose tissue that provides insulation and cushioning.

Sebaceous glands produce sebum, an oily substance that lubricates the skin and hair. Overproduction of sebum combined with dead skin cells can block pores and initiate acne development.

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1.3 Need for the Present Study

The increasing prevalence of acne and limitations associated with conventional therapies have created a need for safer and more effective alternatives. Herbal formulations provide a promising approach because of their therapeutic efficacy and minimal adverse effects.

The present work aims to design, develop, and evaluate a herbal anti-acne gel formulation containing Neem, Aloe Vera, Turmeric, and Tea Tree Oil. These ingredients were selected based on their traditional use and scientifically proven pharmacological properties.

The study includes formulation development, physicochemical evaluation, antimicrobial activity testing, and stability studies to determine the effectiveness and suitability of the herbal formulation for acne treatment.

1.4 Overview of the Research Work

The research work is divided into several stages:

1. Selection of herbal ingredients
2. Extraction of active constituents
3. Preparation of herbal gel formulation
4. Evaluation of physical parameters
5. Stability studies
6. Antimicrobial testing

1. Neem (Azedarach indica)

Acne vulgaris is a chronic inflammatory disorder of the pilosebaceous unit characterized by comedowns, papules, pustules, nodules, and in severe cases, scarring. The major causative factors include excessive sebum production, follicular hyper keratinization, bacterial colonization by Cuti bacterium acnes (Propionibacterium acnes), and inflammatory responses. Conventional anti-acne therapies such as antibiotics, retinoids, and benzoyl peroxide are effective but often produce adverse effects including dryness, irritation, hypersensitivity, and antibiotic resistance. These limitations have increased interest in herbal medicines due to their safety, affordability, and therapeutic efficacy.

Medicinal plants such as neem, aloe vera, turmeric, and tea tree oil have gained significant attention because of their antimicrobial, anti-inflammatory, antioxidant, and wound-healing properties. Several studies have demonstrated their usefulness in dermatological preparations, especially in acne management. (6)

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Botanical Introduction

Neem (Azedarach indica) is an evergreen medicinal tree belonging to the family Meliaceous. It is widely used in Ayurvedic medicine for treating skin disorders, infections, wounds, and inflammatory conditions. Almost every part of the neem plant including leaves, bark, seeds, and oil possesses medicinal value.

Chemical Constituents

Neem contains several biologically active compounds such as:

- Nimbi din
- Azadirachtin
- Nimbi
- Quercetin
- Gaduin
- Limonoids
- Flavonoids

These compounds contribute to the plant's antimicrobial and anti-inflammatory activities.

Pharmacological Properties

Antibacterial Activity

Neem exhibits strong antibacterial activity against acne-causing microorganisms such as Cuti bacterium acnes and Staphylococcus aureus. Neem leaf extracts inhibit bacterial growth and reduce infection associated with acne lesions.

Anti-inflammatory Property

Neem suppresses inflammatory mediators responsible for redness, swelling, and pain in acne lesions. This property helps reduce skin irritation and promotes healing.

Antioxidant Activity

The flavonoids and polyphenols present in neem neutralize free radicals and protect skin cells from oxidative stress.

Wound Healing Property

Neem accelerates tissue regeneration and healing of acne scars and damaged skin.

Previous Studies and Outcomes

Several researchers have reported the effectiveness of neem in dermatological preparations.

Herbal gels containing neem extract showed significant reduction in inflammatory acne lesions due to its antibacterial activity. Studies also revealed that neem-based topical

formulations were well tolerated and caused minimal irritation compared to synthetic anti-acne drugs.

Research findings indicate that neem extracts possess broad-spectrum antimicrobial activity and may serve as an effective natural ingredient in anti-acne herbal formulations.

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3. Turmeric (Curcuma longa)

Botanical Introduction

Turmeric (Curcuma longa) is a rhizomatous herb belonging to the family Zingiberoside. It has been extensively used in Ayurvedic and traditional medicine for its anti-inflammatory and antimicrobial properties.

Chemical Constituents

The major active constituents of turmeric include:

Curcumin
Desmethoxycurcumin
Bisdemethoxycurcumin
Volatile oils
Turmerone
Zingiberene

Previous Studies and Outcomes

Research studies indicate that curcumin possesses therapeutic benefits in inflammatory skin disorders including acne. Laboratory studies demonstrated inhibition of acne-causing bacteria and suppression of inflammatory pathways.

Topical turmeric formulations such as gels, creams, and face masks showed promising anti-acne effects with reduced lesion count and improved skin appearance. However, researchers noted that more large-scale clinical trials are required to establish definitive clinical efficacy. (9)

4. Tea Tre e Oil (Melaleuca alternifolia)

Botanical Introduction

Tea tree oil is an essential oil obtained from the leaves of Melaleuca alternifolia. It has been widely used in dermatology because of its antimicrobial and anti-inflammatory properties.

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Chemical Constituents

Major active constituents include:

Terpinen-4-ol
α-Terpineol
Cineole
γ-Terpinene
α-Pinene

Previous Studies and Outcomes

A randomized clinical study comparing 5% tea tree oil gel with 5% benzoyl peroxide reported that both treatments significantly reduced acne lesions. Tea tree oil showed slower onset of action but produced fewer adverse effects such as dryness and irritation.

Another placebo-controlled clinical trial demonstrated that tea tree oil gel significantly improved acne severity and lesion count compared to placebo.

A review on tea tree oil concluded that it possesses effective antibacterial, anti-inflammatory, and antioxidant activities beneficial in acne management.

However, excessive or undiluted use may cause skin irritation or allergic reactions in sensitive individuals. (11,12)

LITERATURE REVIEW

1. Ana Carolina Proenca, Angelo Luis, Ana Paula Duarte et al., (2022)

Over the past few decades, interest in medicinal plants and phytochemicals for the treatment of skin disorders, including acne vulgaris, has progressively increased. Acne vulgaris is a chronic inflammatory disease of the pilosebaceous unit, which mainly occurs in adolescents and young adults. The treatment focuses on the four main factors involved in its pathogenesis: increased sebum production, hyperkeratinization, overgrowth of Cutibacterium acnes, and inflammation. The treatment includes topical retinoids, benzoyl peroxide, antibiotics, and oral isotretinoin. In this regard, the use of herbal medicine as a complementary and alternative medicine is a promising strategy. The main objective of this study was to systematically evaluate the efficacy and safety of medicinal plants and phytochemicals in the treatment of acne vulgaris. Three scientific databases (PubMed, Web of Science, and Scopus) were searched from inception to January 2021. Clinical trials comparing herbal therapies with placebo or other medicines for the treatment of acne vulgaris were included and analyzed. Outcome measures of interest comprised acne lesions (inflammatory and noninflammatory), sebum production, acne severity, and quality of life. The risk of bias in the included randomized controlled trials (RCTs) was assessed using the Cochrane risk-of-bias tool. A total of 34 clinical trials involving 1753 participants met the inclusion criteria for this systematic review.

2. Suzi Shu Yi Mansu, Meaghan Coyle et al., (2018)

Acne vulgaris is a common inflammatory skin condition characterized by comedones. Current pharmacotherapies are effective but are associated with adverse events (AEs) such as mood disorders and antibiotic resistance. The Eriobotrya japonica Formula (EJF) contains six herbs commonly used in traditional Chinese medicine clinical practice. This paper evaluates the experimental evidence and clinical efficacy of EJF for acne vulgaris.

Searches of 11 English and Chinese databases were conducted to identify eligible randomized controlled trials (RCTs). PubMed was searched for experimental evidence of herbs included in EJF. Meta-analyses were performed to analyse the clinical effects of EJF compared to pharmacotherapies.

Ingredients in EJF were reported to have an effect on inhibiting TNF-α, PPAR-γ and IL-6 cytokines. Some also inhibited P. acnes and had anti-androgenic and anti-lipogenic effects. There were 15 RCTs included in the clinical review. The number of people achieving a clinical improvement based on lesion count was higher with EJF than pharmacotherapies. The effective rate of EJF was greater than antibiotics and benzoyl peroxide (2 studies, RR: 1.47

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[1.23, 1.77], I2 = 0%), and antibiotics with topical supplements (2 studies, RR: 1.77 [1.18, 2.67], I2 = 0%). There were 107 mild AEs reported in 7 trials, 33 in the intervention groups and 74 in the control groups. No serious AEs were reported.

There is some evidence that EJF can decrease inflammatory lesions in acne vulgaris with fewer AEs in the short-term. However, due to methodological limitations of the included trials, results on clinical efficacy should be interpreted with caution.(14)

MATERIAL AND METHODS

Introduction

The materials and methods section describe the complete experimental procedure followed for the design, development, and evaluation of the herbal formulation for the treatment of acne. The study involved selection of suitable herbal ingredients, extraction of active constituents, preparation of herbal formulation, evaluation of physicochemical properties, antimicrobial studies, stability studies, and safety assessment.

The methodology was designed to ensure the preparation of a stable, effective, and safe herbal anti-acne formulation using medicinal plants possessing antimicrobial, anti-inflammatory, antioxidant, and wound-healing properties.

1. Materials

1.1 Herbal MaterialsUsed

The following medicinal plants and natural ingredients were selected based on their pharmacological activities against acne vulgaris.

Sr.no	Herbal Ingredient	Biological Name	Part Used	Role in Formulation
1	Neem	*Azedarach indica*	Leaves	Antibacterial and anti-inflammatory
2	Aloe Vera	*Aloe barbadense Miller*	Leaf gel	Moisturizer and wound healing
3	Turmeric	*Curcuma longa*	Rhizome	Antioxidant and anti-inflammatory
4	Tea Tree Oil	*Melaleuca alternifolia*	Essential oil	Antimicrobial activity

Properties

- Antibacterial
- Antifungal
- Anti-inflammatory
- Antioxidant

Rolein Formulation

Neem was used to inhibit acne-causing bacteria and reduce inflammation.

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Aloe Vera Gel

Properties

- Cooling effect
- Skin hydration
- Wound healing
- Anti-inflammatory

Role in Formulation

Aloe vera was incorporated to soothe irritated skin and improve healing of acne lesions.

Turmeric Rhizome

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Properties
• Antioxidant
• Antimicrobial
• Anti-inflammatory
Role in Formulation
Turmeric was included to reduce redness, pigmentation, and bacterial infection.

Tea Tree Oil

Properties
• Antimicrobial
• Sebum control
• Anti-inflammatory
Role in Formulation
Tea tree oil was used to control acne-causing microorganisms and excessive oil secretion.

1.3 Chemicals and Excipients Used

S. No.	Chemical/Excipient	Purpose
1	Carbopol 940	Gelling agent
2	Triethanolamine	pH adjustmer
3	Glycerin	Humectant
4	Ethanol	Solvent for extraction
5	Distilled Water	Vehicle
6	Methyl Paraben	Preservative
7	Propyl Paraben	Preservative

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1.3 Equipment Used

S. No.	Equipment	Purpose
1	Soxhlet Apparatus	Extraction
2	Hot Air Oven	Drying
3	Rotary Evaporator	Solvent removal
4	pH Meter	pH determination
5	Brookfield Viscometer	Viscosity measurement
6	Electronic Balance	Weighing
7	Magnetic Stirrer	Mixing
8	Incubator	Microbial studies

2. Methods

2.1 Collection and Authentication of Plant Materials

Fresh neem leaves, aloe vera leaves, turmeric rhizomes, and tea tree oil were procured from local herbal suppliers and authenticated by a pharmacognosy expert. The plant materials were cleaned thoroughly using distilled water to remove dirt and impurities.

2.4 Preparation of Herbal Gel Formulation

Preparation of Herbal Gel Base:

Ingredients	F1	F2	F3	F4	F5	F6	F7	F8	F9
Carbapol 934	0.5gm	1gm	1.5gm	-	-	-	-	-	-
Sodium CMC	-	-	-	0.5gm	1gm	1.5gm	-	-	
HPMC	-	-	-	-	-	-	0.5gm	1gm	1.5gm
Span 80	0.2ml	0.2ml	0.2ml	0.2ml	0.2ml	0.2ml	0.2ml	0.2ml	0.2ml
PEG 400	0.25ml	0.25ml	0.25ml	0.25ml	0.25ml	0.25ml	0.25ml	0.25ml	0.25ml
Methyl Paraben	0.2gm	0.2gm	0.2gm	0.2gm	0.2gm	0.2gm	0.2gm	0.2gm	0.2gm
Dil .water	30ml	30ml	30ml	30ml	30ml	30ml	30ml	30ml	30ml

- Generally the water soluble excipients are firstly dissolved in vehicle, in a mixing vessel by using mechanical stirrer. To prevent aggregation, add hydrophilic polymer to the stirred mixture slowly.
- Stirring is continued until the dissolution of the polymer has occurred. The excessive stirring results in entrapment of air.
- The mixing rate must not be extreme or a mixing vessel may be used to which a vacuum may be pulled, to prevent the entrapment of air.

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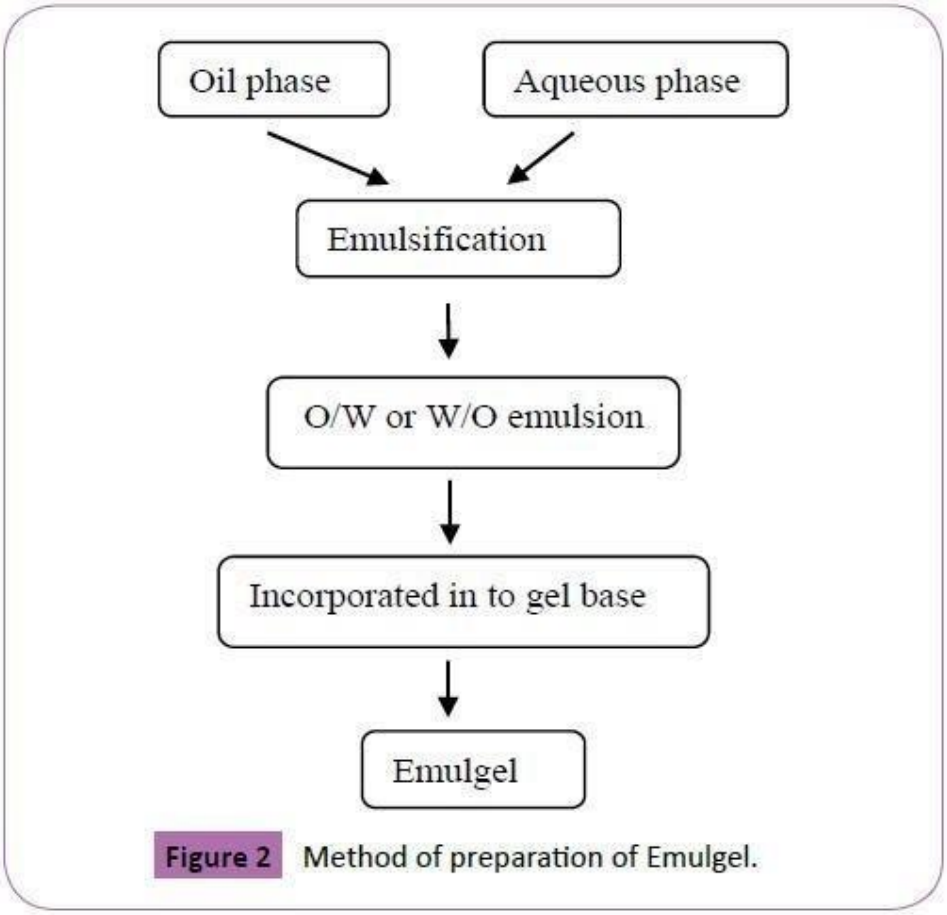

Figure 2 Method of preparation of Emulgel.

FORMULATION DESIGN

Formulation design is an important step in the development of stable, effective, and patient-friendly herbal anti-acne preparation. The present study was focused on designing a topical herbal gel formulation containing medicinal plant extracts with antimicrobial, anti-inflammatory, antioxidant, moisturizing, and wound-healing properties. The formulation was prepared using neem, aloe vera, turmeric, and tea tree oil as active herbal ingredients due to their proven therapeutic benefits in acne treatment.

A gel formulation was selected because gels are non-greasy, easy to apply, aesthetically acceptable, and suitable for oily and acne-prone skin. The formulation was designed to provide prolonged contact with the skin, better penetration of active constituents, and improved patient compliance.

The formulation design involved:

- Selection of active herbal ingredients
- Selection of suitable excipients
- Determination of ingredient concentration
- Preparation of gel base
- Incorporation of herbal extracts
- Evaluation of formulation stability and compatibility

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1. Selection of Dosage Form Choice of Herbal Gel

A herbal gel dosage form was selected for the following reasons: Advantages of Gel Formulation

- Non-sticky and non-greasy
- Easily spreadable on skin
- Better patient acceptability
- Good appearance and transparency
- Rapid absorption into skin
- Cooling and soothing effect
- Suitable for oily and acne-prone skin
- Easy removal by washing

Compared to creams and ointments, gels provide better drug release and do not block skin pores, making them more suitable for acne management. (26)

Preservatives (Methyl Paraben and Propyl Paraben) Function

These preservatives prevent microbial contamination and improve shelf life of the formulation.

Adv•a ntPargoetsect formulation from spoilage

- Maintain product quality
- Increase stability during storage

6. Preparation Method of Herbal Gel

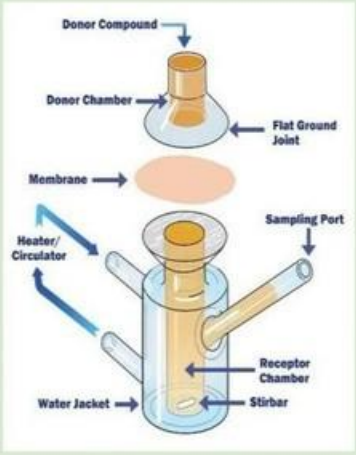
EVALUATION OF HERBAL GEL:

d)In vitro drug diffusion study from the Herbal gel formulation through cellulose membrane:

Modified Franz diffusion cell were used for the study of drug permeation through Herbal gel. 1gram of Herbal gel was kept in the donor compartment. In the receiver compartment P.B.S. pH 6.8 and Dis. Water was kept. 3 ml sample was withdrawn every hr. from the receiver compartment and replaced by the fresh medium of equal volume.

e) Stability Study:

The stability study of formulation was performed as per International Council for Harmonisation (ICH) guidelines. Freshly prepared formulation was divided into groups and kept at specified storage condition as per ICH guidelines. Sample were withdrawn periodically and tested for various evaluation parameters mentioned above. Stable formulation must retain the evaluation parameters at specified storage conditions over a period of time.



SIMPLE CELL APPARATUS

Stepwise Procedure Step1:Preparation ofGelBase

Carbopol 940 was dispersed slowly in distilled water with continuous stirring to avoid lump formation.

Step 2: Hydration

The mixture was allowed to stand for complete hydration of Carbopol.

Step 3: Addition of Humectant

Glycerin was added slowly and mixed uniformly.

Step 4: Incorporation of Herbal Extracts

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Prepared neem extract, turmeric extract, aloe vera gel, and tea tree oil were added gradually with continuous stirring.
Step 5: Addition of Preservatives
Methyl paraben and propyl paraben were dissolved and incorporated into the formulation.
Step 6: pH Adjustment
Triethanolamine was added dropwise until the gel achieved a skin-compatible pH of approximately 6.0–6.8.

EVALUATION PARAMETERS

Evaluation of herbal formulations is an essential step in determining the quality, safety, efficacy, stability, and acceptability of the developed product. The prepared herbal anti-acne gel was evaluated using various physicochemical, microbiological, and stability parameters to ensure that the formulation is suitable for topical application and capable of producing effective therapeutic action against acne vulgaris.

The evaluation parameters were selected according to standard pharmaceutical and cosmetic guidelines. These tests help in assessing the formulation's consistency, skin compatibility, spread ability, antimicrobial effectiveness, and shelf stability.

The developed herbal formulation containing neem, aloe vera, turmeric, and tea tree oil was evaluated for:

- Physical appearance
- Homogeneity
- pH
- Viscosity
- Spread ability
- Washability
- Stability studies
- Microbial limit test
- In-vitro antimicrobial activity

1. Physical Evaluation

Physical evaluation was carried out to determine the appearance, texture, consistency, color, odor, and overall acceptability of the herbal gel formulation.

Parameters Evaluated

S. No.	Parameter	Method
1	Color	Visual observation
2	Odor	Sensory evaluation
3	Appearance	Visual inspection
4	Consistency	Manual examination
5	Homogeneity	Touch and visual inspection
6	Texture	Finger feel method
7	Phase Separation	Storage observation(28,29)

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Observation Table for Physical Evaluation

Parameter	Observation	Result
Color	Light greenish yellow	Acceptable
Odor	Characteristic herbal odor	Pleasant
Appearance	Smooth gel	Good
Consistency	Semi-solid	Suitable
Homogeneity	Uniform	Satisfactory
Texture	Non-gritty	Good
Phase Separation	Absent	Stable

RESULT

The present study was carried out to design, develop, and evaluate a herbal anti-acne gel formulation using neem, aloe vera, turmeric, and tea tree oil. The developed formulation was subjected to various physicochemical, microbiological, and stability evaluation parameters to determine its quality, safety, and therapeutic effectiveness.

The prepared herbal gel exhibited satisfactory appearance, consistency, homogeneity, and stability suitable for topical application. The formulation showed a smooth texture with light greenish-yellow color and characteristic herbal odor. No phase separation or grittiness was observed during the study period, indicating proper formulation and compatibility of ingredients.

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Physical Evaluation Results

Parameter	Observation
Color	Light greenish yellow
Odor	Pleasant herbal odor
Appearance	Smooth gel Semi-solid
Consistency	
Homogeneity	Uniform

The formulation demonstrated good aesthetic appearance and patient acceptability.

pHE valuation Results

The pH of the formulation was found to be 6.43, which lies within the normal skin pH range.

Trial pH Value

1 6.4

2 6.5

3 6.4

The observed pH confirmed that the formulation is suitable for topical use without causing skin irritation.

Viscosity and Spread ability Results

The prepared gel showed suitable viscosity and spread ability, ensuring easy application and uniform distribution on the skin surface.

Parameter	Result
Average Viscosity	33,900 cP
Average Spread ability	17.6 gm./sec

The formulation exhibited pseudoplastic flow behavior, which is desirable for topical gel preparations.

Stability Study Results

The formulation remained stable under refrigerated, room temperature, and accelerated storage conditions for the study period. No significant changes in color, odor, consistency, pH, or phase separation were observed.

II. CONCLUSION

The developed herbal formulation serves as a highly viable, gentle, and sustainable botanical therapy for acne-prone skin. Its exclusion of synthetic chemicals reduces the risk of adverse side effects, offering patients a safe path toward achieving a clearer complexion. Future long-term clin ical trials will further solidify its role as a primary or supportive treatment in dermatology.

This study aimed at developing a herbal gel for anti-acne treatment using extracts of Aloevera and Curcuma longa in an aqueous based gel system. Four formulations of the gel were prepared by varying the proportions of gelling agents and evaluated for their physicochemical properties, like pH, spreadability, viscosity, and skin irritation study and microbial contamination tests.

Based on these tests, formulation G3 was selected as the best formulation. The microbial enumeration studies of all the formulations demonstrated better microbial activity against various microorganisms stood competitive to the standard formulation. It was concluded that tshenpt re search might hopefully bring advancement in the treatment of acnes using herbs as well as in developing poly herbal formulations for safe and effective management of diseases.

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