



International Journal of Research in Pharmaceutical and Nano Sciences

Journal homepage: www.ijrpns.com

<https://doi.org/10.36673/IJRPNS.2026.v15.i02.A05>



FORMULATION AND EVALUATION OF HERBAL ANTI ACNE GEL

Faizan Raza^{*1}, Moim Raja¹, Nitish Yadav¹, Chandramani Chaurasiya¹, Rohit Prajapati¹, Vishal Singh¹

¹Suyash Institute of Pharmacy, Hakkabad, Gorakhpur, Uttar Pradesh, India.

ABSTRACT

Acne vulgaris is a chronic inflammatory disorder of the pilosebaceous unit, commonly characterized by the formation of comedones, papules, pustules and increased sebum secretion. It affects a large proportion of the adolescent and adult population and may lead to physical as well as psychological distress. Although several synthetic treatments are available, their use is often associated with adverse effects such as skin irritation, dryness and microbial resistance. This has led to a growing interest in herbal therapies, which are generally considered safer, cost-effective and more acceptable to patients. The present study was undertaken to formulate and evaluate a herbal anti-acne gel incorporating ethanolic extracts of *Azadirachta indica* and *Allium sativum*. Both plants are well known for their antimicrobial, anti-inflammatory and antioxidant properties. The extracts were prepared using ethanol as a solvent and incorporated into a suitable gel base to obtain a stable topical formulation. The prepared gel was evaluated for various physicochemical parameters including appearance, homogeneity, pH, spread-ability and extrudability to ensure its suitability for topical application. Furthermore, the anti-acne activity of the formulation was assessed against *Staphylococcus aureus* using standard microbiological techniques. The results demonstrated that the formulated gel exhibited satisfactory physical characteristics and was compatible with skin pH. The combination of Neem and Garlic extracts showed significant antimicrobial activity, with enhanced effectiveness observed when used together, indicating a synergistic effect. In conclusion, the developed herbal anti-acne gel possesses promising therapeutic potential and could serve as a safer alternative to conventional synthetic treatments for acne vulgaris. Further clinical studies are recommended to validate its efficacy and safety in human subjects.

KEYWORDS

Acne vulgaris, Herbal anti-acne gel, *Azadirachta indica*, *Allium sativum*, Aloe vera, Antimicrobial activity, Phytochemicals, Topical formulation, Sebum control, Skin inflammation, Cutibacterium acnes, *Staphylococcus aureus*, Natural remedies, Herbal cosmetics, Gel formulation, Antioxidant activity, Anti-inflammatory agents, Dermatological preparation, Stability studies, Spread-ability and pH evaluation.

Author for Correspondence:

Faizan Raza,
Suyash Institute of Pharmacy,
Hakkabad, Gorakhpur, Uttar Pradesh, India.

Email: fk1755570@gmail.com

INTRODUCTION

The term acne is derived from the Greek word “Akme,” meaning peak or highest point, and refers to disorders affecting the pilosebaceous units of the skin¹. The medically accurate term for this condition is acne vulgaris, which is one of the most prevalent dermatological disorders, especially among young individuals between 18 and 25 years

of age². It is characterized by excessive sebum production (seborrhea), formation of comedowns, inflammatory lesions, and microbial colonization within the follicular canal³.

Acne vulgaris is considered nearly universal, affecting approximately 95% of males and 83% of females across different populations⁴. The condition is strongly associated with microorganisms such as *Propionibacterium acnes* (now known as *Cutibacterium acnes*), *Staphylococcus epidermidis*, and *Staphylococcus aureus*. Among these, *Propionibacterium acnes* is an obligate anaerobic bacterium that plays a key role in acne pathogenesis⁵. It contributes to inflammation by activating the complement system and breaking down sebaceous triglycerides into free fatty acids, which attract neutrophils and promote inflammatory responses⁶.

On the other hand, *S. epidermidis* is commonly involved in superficial infections within sebaceous glands, while *S. aureus* may proliferate when skin integrity is compromised, further worsening acne lesions. These microorganisms represent important targets for anti-acne therapy⁷.

However, prolonged and excessive use of conventional antibiotics has led to the emergence of resistant strains of acne-causing bacteria⁸. This resistance is influenced by multiple factors, including drug usage patterns, microbial characteristics, host factors and environmental conditions. As a result, there is a growing interest in exploring alternative therapeutic options⁹.

Medicinal plants have gained attention due to their antimicrobial and anti-inflammatory properties¹⁰. Plants such as *Azadirachta indica* (Neem) and *Allium sativum* (Garlic) have been traditionally used to treat skin infections. Both exhibit significant activity against acne-related pathogens like *Staphylococcus aureus*¹¹. However, direct application of neem or garlic extracts on the skin may cause irritation and is inconvenient¹².

Therefore, formulating these herbal extracts into a topical gel offers a more effective and patient-friendly approach. Gels provide a cooling effect, are easily absorbed into the skin and form a thin film

that can be conveniently washed off¹³. The primary aim of this study is to formulate and evaluate a herbal anti-acne gel containing neem and garlic extracts using standard evaluation methods¹⁴.

Neem (*Azadirachta indica*)¹⁵

Synonyms

Nira, Nimb, Vespa, Limba, Nimba

Biological Source

Neem consists of the fresh or dried leaves and seed oil of *Azadirachta indica* belonging to the family Meliaceae¹⁶.

Chemical Constituents

Neem contains several important phytochemicals including Nimbin, Nimbidin, Nimbolide, 6-desacetylnimbinene, Nimbiene, Nimbandiol, Quercetin, Ascorbic acid, n-hexacosanol and amino acids¹⁸.

Geographical Source

Neem is widely distributed in tropical and subtropical regions such as India, Pakistan, Sri Lanka, Indonesia, Malaysia, Japan, Australia and Africa²⁰. In India, it is commonly found in Uttar Pradesh, Maharashtra, Tamil Nadu, Rajasthan, and Madhya Pradesh.

Uses (Pharmacological Importance)

Antibacterial and antifungal activity

Anti-acne and skin cleansing agent

Anti-inflammatory and antioxidant properties

Garlic (*Allium sativum*)²¹

Synonyms

Lahtsun, Rasona, Lasuna, Allium

Biological Source

Garlic consists of the fresh or dried bulbs (cloves) of *Allium sativum* belonging to the family Amaryllidaceae²².

Chemical Constituents

Garlic contains important sulfur-containing compounds such as Alliin, Allicin, Ajoene, Diallyl disulfide, and Diallyl trisulfide. It also contains enzymes (alliinase), flavonoids, saponins and vitamins like Vitamin C and B-complex²⁴.

Geographical Source

Garlic is widely cultivated in India, China, Egypt, and Mediterranean countries. In India, it is

commonly grown in Madhya Pradesh, Uttar Pradesh, Rajasthan and Gujarat²⁶.

Uses (Pharmacological Importance):

Antibacterial and antifungal agent

Cardioprotective (reduces cholesterol and blood pressure)

Antioxidant and anti-inflammatory

Used in treating infections and boosting immunity

Aloe Vera²⁷

Synonyms:

Ghrithkumari, Kumari, Indian Aloe, Barbados Aloe.

Biological Source

Aloe vera consists of the fresh or dried juice obtained from the leaves of *Aloe vera* belonging to the family Asphodelaceae²⁸.

Chemical Constituents

Aloe vera contains a wide range of active compounds such as Aloin (barbaloin), Aloe-emodin, Anthraquinones, Polysaccharides (acemannan), Glycoproteins, Vitamins (A, C, E, B-complex), Enzymes, Amino acids and minerals like calcium, magnesium and zinc²⁹.

Geographical Source

Aloe vera is widely distributed in tropical and subtropical regions across the world, including India, Africa, the Mediterranean region and the Caribbean. In India, it is commonly cultivated in Rajasthan, Gujarat, Tamil Nadu and Maharashtra³⁰.

Uses (Pharmacological Importance)

Promotes wound healing and skin regeneration

Acts as a moisturizing and soothing agent

Shows antibacterial and anti-inflammatory properties

Used in treatment of burns, cuts and acne

Common ingredient in cosmetics and herbal formulations.

Honey³¹

Synonyms

Madhu, Shahad, Bee honey, Natural honey

Biological Source

Honey is a naturally occurring sweet substance prepared by honeybees, mainly *Apis mellifera*. Bees collect nectar from flowers, convert it through enzymatic activity and store it in honeycombs. These bees belong to the family Apidae³².

Chemical Constituents

Honey is mainly composed of sugars along with several minor bioactive components:

Sugars: Fructose and glucose are present in the highest amount, with small quantities of sucrose

Enzymes: Invertase, diastase, and glucose oxidase

Vitamins: Small amounts of B-complex vitamins and vitamin C

Minerals: Calcium, potassium, iron and magnesium

Other components: Amino acids, organic acids (such as gluconic acid), and natural antioxidants like flavonoids³³.

Geographical Source

Honey is obtained in many parts of the world where flowering plants and bees are present. It is widely produced in countries such as India, China, the United States and Australia.

Within India, honey is commonly collected from regions like Uttar Pradesh, Punjab, Bihar, West Bengal, and Himachal Pradesh³⁴.

Lemon Juice³⁵

Synonyms

Nimbu ras, Citrus juice, Lemon extract

Biological Source

Lemon juice is obtained by squeezing the fresh fruits of *Citrus limon*, which belongs to the family Rutaceae. The juice is present in the pulp of the fruit and is widely used for medicinal and nutritional purposes³⁶.

Chemical Constituents

Mainly citric acid (major component), along with malic acid, rich in vitamin C (ascorbic acid), small amounts of vitamin B-complex, Potassium, calcium, and magnesium, Hesperidin, eriocitrin (antioxidants), Limonene and other volatile compounds³⁷.

Geographical Source

Lemon is cultivated in many tropical and subtropical regions across the world. Major producers include India, Mexico, China and Mediterranean countries.

In India, it is widely grown in states such as Uttar Pradesh, Maharashtra, Andhra Pradesh, Tamil Nadu and Gujarat³⁸.

LITERATURE REVIEW

Sharma *et al.*, (2015) developed an herbal anti-acne gel incorporating neem and tea tree oil. Their study highlighted the strong antibacterial properties of both ingredients against *Propionibacterium acnes*. *In-vitro* antimicrobial testing showed significant zones of inhibition, indicating effective bacterial suppression. The formulation was well accepted by users due to its soothing effect and non-oily texture. Skin irritation studies confirmed that the gel was safe for topical use, with no adverse reactions observed. The researchers concluded that herbal extracts could serve as a safer alternative to synthetic drugs³⁹.

Verma and Singh (2016) formulated an anti-acne gel using aloe vera and turmeric extracts. Their study demonstrated remarkable anti-inflammatory activity, with a noticeable reduction in redness and swelling within a week of application. Turmeric acted as a potent antioxidant and antimicrobial agent, while aloe vera provided moisturizing and healing effects. Stability testing confirmed that the formulation maintained its efficacy over time, indicating a satisfactory shelf-life. The study emphasized the importance of aloe vera in promoting skin repair and hydration⁴⁰.

Deshpande *et al.*, (2017) investigated a polyherbal formulation containing basil, cinnamon, and clove. The study focused on antimicrobial activity as well as skin penetration ability. Results showed that clove exhibited strong antibacterial activity against acne-causing organisms, while basil contributed to soothing irritated skin. Volunteers reported smoother and healthier skin after two weeks of application. This study highlighted the potential of spice-derived herbal ingredients in dermatological formulations⁴¹.

Kumar and Rani (2017) evaluated the synergistic effects of tulsi and green tea extracts in an anti-acne gel. Green tea acted as an antioxidant and astringent, helping to tighten pores and reduce excessive oil secretion. Clinical observations revealed a significant reduction in acne lesions after four weeks of regular use⁴². Importantly, no side effects were reported during the study, supporting

the safety of herbal formulations. The findings reinforced the use of phytoconstituents in managing mild to moderate acne conditions⁴³.

Mehta and Joshi (2018) focused on a combination of aloe vera and calendula in gel formulation. Calendula is known for its wound-healing and antimicrobial properties, while aloe vera provides soothing and hydrating effects. The formulation exhibited good spreadability and a pleasant texture, making it user-friendly. Stability studies indicated that the gel could be stored for up to six months without significant changes in its properties. The research validated the effectiveness of calendula in treating acne-prone skin⁴⁴.

Iqbal *et al.*, (2018) developed a gel containing salicylic acid combined with tea tree oil. The formulation showed strong keratolytic activity, which helped in removing dead skin cells and unclogging pores. Tea tree oil contributed anti-inflammatory effects, reducing redness and irritation. Clinical trials conducted on 30 volunteers demonstrated that the formulation was effective against both blackheads and whiteheads. The study concluded that the combination therapy was more effective than salicylic acid alone⁴⁵.

Goyal and Tiwari (2019) explored the use of manjistha and turmeric in a herbal gel. The formulation was rich in flavonoids and curcuminoids, which possess strong antioxidant properties. The study reported reduced sebum production and a decrease in acne lesion size. Manjistha was also found to improve overall skin tone and complexion. The formulation was considered suitable for long-term use due to its safety and effectiveness⁴⁶.

Rathod and Kale (2019) prepared a herbal anti-acne gel using neem, garlic and lemon extracts. These ingredients were selected for their antibacterial and antiseptic properties⁴⁷. The gel was pH-balanced and specifically tested on individuals with oily skin. Lemon extract contributed to the lightening of acne scars, enhancing the overall appearance of the skin. The study reported minimal irritation and high user satisfaction, indicating good acceptability of the formulation⁴⁸.

Taneja *et al*, (2020) studied a gel formulation containing *Centella asiatica* and licorice root. The formulation not only targeted acne but also improved skin hydration and elasticity. *Centella asiatica* was found to stimulate collagen synthesis, which helped in healing acne scars. The study introduced a dual-action approach, combining acne treatment with skin regeneration, making it a unique contribution to herbal dermatology⁴⁹.

Patel and Bhatt (2020) conducted a comparative study between herbal and synthetic anti-acne formulations. The herbal gel, containing tulsi and aloe vera, was compared with a synthetic formulation containing benzoyl peroxide. Although both formulations showed similar efficacy in reducing acne, the herbal gel was significantly less irritating and more tolerable, especially for sensitive skin. This study supported the use of herbal products as safer alternatives to chemical-based treatments⁵⁰.

Khan and Shaikh (2021) introduced a personalized herbal anti-acne gel system. The formulation allowed customization based on individual skin types, using ingredients such as mint, licorice, and aloe vera. This approach improved user satisfaction and engagement, highlighting the importance of personalized skincare. The study suggested that customization could be a future trend in herbal dermatological formulations⁵¹.

Bansal *et al*, (2021) developed a hydrogel-based system for delivering herbal actives like neem and turmeric. The hydrogel provided sustained release of active compounds, enhancing therapeutic effectiveness. It also maintained skin hydration and offered a cooling effect. Stability and rheological studies confirmed the suitability of the formulation for topical application. This study successfully combined modern drug delivery techniques with traditional herbal medicine⁵².

Mishra and Tiwari (2022) evaluated the anti-acne potential of a formulation containing sea buckthorn and aloe vera. Sea buckthorn provided antioxidant protection, while aloe vera reduced inflammation and promoted healing. The combination accelerated the recovery of acne lesions and minimized

scarring. Visible improvement was observed within 10 days of application, demonstrating the effectiveness of the formulation⁵¹.

Yadav and Chauhan (2023) explored a gel containing saffron and sandalwood for acne-prone skin. Saffron exhibited antibacterial and anti-pigmentation properties, helping to reduce dark spots and improve skin tone. Sandalwood provided a soothing effect and reduced inflammation. Dermatological testing confirmed the safety and mildness of the formulation, making it suitable for regular use⁵³.

Kulkarni *et al*, (2023) investigated a combination of turmeric, honey, and cinnamon in an anti-acne gel. The formulation demonstrated strong synergistic effects, with honey acting as a natural humectant that maintained skin moisture. The gel effectively reduced inflammation and improved skin texture⁵⁴. Statistical analysis showed a significant reduction in acne lesions, particularly in adolescents. The study recommended this formulation for managing acne in young individuals⁵⁵.

PLAN OF WORK

The present study on the formulation and evaluation of a herbal anti-acne gel was carried out in a systematic and stepwise manner to ensure accuracy, reproducibility, and reliability of results. The overall plan of work is described below:

Selection of Herbal Ingredients

Medicinal plants such as *Azadirachta indica* (Neem), *Allium sativum* (Garlic), and *Aloe vera* were selected based on their reported antimicrobial, anti-inflammatory, and antioxidant properties useful in the treatment of acne⁵⁶.

Collection and Preparation of Raw Materials

The plant materials were collected and cleaned properly to remove impurities. Fresh aloe vera gel was extracted from leaves and garlic bulbs were processed. Neem leaves were dried and powdered for extraction⁵⁷.

Preparation of Extracts

Ethanollic extracts of neem and garlic were prepared using suitable extraction techniques to obtain active

phytoconstituents responsible for antimicrobial activity⁵⁸.

Formulation of Herbal Gel

Different formulations (F1, F2 and F3) were prepared using aloe vera gel as a base along with guar gum as a thickening agent. Honey, lemon juice and rose water were incorporated to improve stability, consistency, and therapeutic effect⁵⁹.

Optimization of Formulation

The formulations were modified by varying concentrations of active ingredients to obtain the best combination in terms of consistency, stability and antimicrobial effectiveness⁶⁰.

Evaluation of Formulations

The prepared gels were evaluated for various parameters including:

Physical properties (appearance, homogeneity, consistency)

pH determination

Spreadability and extrudability

Viscosity

Washability and skin irritation test

Antimicrobial activity against *Staphylococcus aureus*

Stability studies under different conditions⁶¹

Data Analysis and Interpretation

The obtained results were compared among different formulations (F1, F2 and F3) to determine the best formulation based on effectiveness and stability⁶².

Conclusion

Based on the evaluation results, conclusions were drawn regarding the suitability and effectiveness of the herbal anti-acne gel. The entire study was compiled systematically for presentation and submission⁶³.

METHODOLOGY

METHOD OF PREPARATION F1 – Standard Formulation

Step 1: Preparation of Aloe Vera Gel Base

Take 30g of fresh aloe vera gel.

Wash the leaves thoroughly and remove the outer green layer.

Collect the inner transparent gel and filter it to remove fibers⁷⁰.

Step 2: Preparation of Guar Gum Dispersion

Take 0.75g guar gum.

Add it slowly into a portion of rose water (≈10g) with continuous stirring.

Allow it to stand for 15-20 minutes for proper hydration⁷¹.

Step 3: Formation of Gel Base

Add the prepared guar gum dispersion into the aloe vera gel.

Mix thoroughly using continuous stirring until a uniform gel base is formed⁷².

Step 4: Incorporation of Neem Extract

Add 1.0g neem extract slowly into the gel base.

Stir continuously to ensure uniform mixing⁷³.

Step 5: Incorporation of Garlic Extract

Add 0.5g garlic extract into the mixture.

Continue stirring to achieve homogeneity⁷⁴.

Step 6: Addition of Honey

Add 1.8ml honey to the gel.

Mix thoroughly until evenly distributed⁷⁵.

Step 7: Addition of Lemon Juice

Add 0.5g lemon juice dropwise with continuous stirring⁷⁶.

Step 8: Addition of Remaining Rose Water

Add the remaining rose water (to make total 14.75g) gradually.

Mix continuously⁷⁷.

Step 9: Final Homogenization

Stir the formulation continuously until

Smooth texture is obtained.

Uniform consistency is achieved.

No lumps or phase separation are present.

Transfer the gel into a clean, airtight container⁷⁸.

METHOD OF PREPARATION (F2 – High Antimicrobial Herbal Gel, 50g)

Step 1: Preparation of Aloe Vera Gel Base

Accurately weigh 28ml of aloe vera gel.

Wash fresh leaves thoroughly, remove the outer rind and collect the inner gel.

Filter the gel to remove fibers and impurities⁸⁵.

Step 2: Preparation of Guar Gum Dispersion

Weigh 0.75g guar gum.

Add it slowly into a portion of rose water (~10g) with continuous stirring.

Allow it to hydrate for 15-20 minutes⁸⁶.

Step 3: Formation of Gel Matrix

Add the hydrated guar gum dispersion to the aloe vera gel.

Stir continuously until a uniform gel matrix is formed⁸⁷.

Step 4: Incorporation of Neem Extract

Add 1.5g neem extract slowly into the gel base.

Mix thoroughly with continuous stirring⁸⁸.

Step 5: Incorporation of Garlic Extract

Add 1.0g garlic extract into the formulation.

Stir continuously to achieve homogeneity⁸⁹.

Step 6: Addition of Honey

Add 2.5ml honey into the gel.

Mix uniformly⁹⁰.

Step 7: Addition of Remaining Rose Water

Add the remaining rose water (to make total 15.75ml) gradually.

Continue stirring⁹¹.

Step 8: Final Homogenization

Stir the formulation continuously until:

Smooth texture is achieved

No lumps are present

Uniform consistency is obtained

Transfer the gel into a clean, airtight container⁹².

METHOD OF PREPARATION (F3 – Herbal Anti-Acne Gel, 50g)

Step 1: Preparation of Aloe Vera Gel

Accurately weigh 32ml of aloe vera gel.

Wash fresh leaves thoroughly and remove the outer green layer.

Collect the inner gel and filter to remove fibers¹⁰⁰.

Step 2: Hydration of Guar Gum

Weigh 1.0g guar gum.

Slowly add it into a portion of rose water (~8-10g) with continuous stirring.

Allow it to hydrate for 15-20 minutes¹⁰¹.

Step 3: Formation of Gel Base

Add the hydrated guar gum dispersion into aloe vera gel.

Stir continuously until a thick, uniform gel base is formed¹⁰².

Step 4: Incorporation of Neem Extract

Add 1.0g neem extract slowly into the gel base.

Mix thoroughly⁹⁷.

Step 5: Incorporation of Garlic Extract

Add 0.5g garlic extract with continuous stirring¹⁰³.

Step 6: Addition of Honey

Add 2.0ml honey and mix uniformly¹⁰⁴.

Step 7: Addition of Lemon Juice

Add 0.5g lemon juice dropwise¹⁰⁵.

Step 8: Addition of Rose Water

Add remaining rose water (to make total 13g) gradually.

Continue stirring¹⁰⁶.

Step 9: Final Homogenization

Stir continuously until:

Smooth texture is obtained

No lumps are present

Uniform consistency is achieved

Transfer into a clean, airtight container¹⁰⁷.

RESULTS

Physical Appearance

Method

All formulations were visually inspected for color, clarity, consistency and presence of lumps¹⁰⁸.

pH Determination

Method

The pH was measured using a calibrated digital pH meter at room temperature¹⁰⁹.

Spread-ability

Method

Measured using the slip and drag method using glass slides¹¹⁰.

Formula

$$S = M \times L / T$$

Extrudability

Method

Measured by determining the force required to extrude gel from a collapsible tube¹¹¹.

Viscosity

Method

Measured using a Brookfield viscometer¹¹².

Homogeneity Test

Method

The gel was pressed between fingers to check for uniformity¹¹³.

Results

All formulations were smooth and free from lumps.

Washability

Method

Applied on skin and washed with tap water¹¹⁴.

Skin Irritation Test

Method

Applied on a small area of skin for 24 hours¹¹⁵.

Antimicrobial Activity

Method

Agar well diffusion method against *Staphylococcus aureus*¹¹⁶.

Stability Studies

Method

Stored at different conditions (room temperature and elevated temperature) for 4 weeks¹¹⁷.

TLC (Thin Layer Chromatography)

Purpose

To separate and identify phytochemicals in extracts.

Materials

TLC plate (silica gel), Solvent system: Toluene: Ethyl acetate (7:3)

Procedure

Prepare extract solution in ethanol.

Spot sample on TLC plate using capillary tube.

Place plate in developing chamber containing solvent.

Allow solvent to travel up to 8 cm.

Remove and dry plate.

Observe under UV light (254nm)¹¹⁸.

Column Chromatography (Column Test)

To isolate and purify active components from herbal extracts.

Materials

Glass column, Silica gel (stationary phase), Solvent: Hexane → Ethyl acetate gradient

Procedure

Pack column with silica gel.

Load extract on top of column.

Elute using solvent system starting from non-polar to polar.

Collect fractions in test tubes.

Analyze fractions using TLC¹¹⁹.

UV SPECTROPHOTOMETRIC ANALYSIS

Switch on UV spectrophotometer and allow it to stabilize.

Set wavelength range from 200-400nm.

Use methanol as blank.

Fill cuvette with sample solution.

Record absorbance spectrum.

Note λ_{max} (maximum absorption wavelength)¹²⁰.

DISCUSSION

The study successfully developed and evaluated herbal anti-acne gels using neem and garlic extracts. All formulations showed acceptable physical properties, proper consistency and skin-friendly pH, indicating their suitability for topical use.

F1 demonstrated the best spread-ability and ease of application, while F3 showed higher viscosity and better stability. F2 exhibited the strongest antimicrobial activity against *Staphylococcus aureus* due to the higher concentration of active herbal extracts, though it caused mild skin irritation. The results confirm that the combination of neem and garlic provides effective antibacterial action, possibly due to their synergistic effect. Other ingredients like aloe vera and honey contributed to soothing, moisturizing and improving overall formulation quality.

Overall, the herbal gel proved to be stable, effective and a safer alternative to synthetic anti-acne products, although further clinical studies are needed for confirmation.

F1 – Standard Formulation**Table No.1: Standard Formulation**

S.No	Ingredient	Quantity (for 50g)	Role in Formulation	Reference
1	Neem extract (<i>Azadirachta indica</i>)	1.0g	Antibacterial, anti-inflammatory; inhibits acne-causing bacteria	64
2	Garlic extract (<i>Allium sativum</i>)	0.5g	Broad-spectrum antimicrobial due to allicin; reduces infection	65
3	Aloe vera gel	30ml	Natural gel base; soothing, moisturizing, wound healing	37
4	Guar gum	0.75g	Natural thickening and stabilizing agent; improves viscosity	66
5	Honey	1.8ml	Humectant; retains moisture and provides antibacterial effect	67
6	Lemon juice	0.5ml	pH adjuster; natural preservative due to citric acid	68
7	Rose water	q.s to 50g	Vehicle; improves consistency, fragrance and skin feel	69

F2 – High Antimicrobial Formulation**Table No.2: High antimicrobial formulation**

S.No	Ingredient	Quantity (g)	Role	Reference
1	Neem extract (<i>Azadirachta indica</i>)	1.5g	Enhanced antibacterial activity	79
2	Garlic extract (<i>Allium sativum</i>)	1.0g	Strong antimicrobial action	80
3	Aloe vera gel	28ml	Gel base, healing agent	81
4	Guar gum	0.75g	Thickener	82
5	Honey	2.5ml	Moisturizer, antibacterial	57
6	Lemon juice	0.5ml	Preservative	83
7	Rose water	15.75ml	Vehicle	84

F3 – High Viscosity / Stability Formulation**Table No.3: High Viscosity Formulation**

S.No	Ingredient	Quantity (g)	Role	Reference
1	Neem extract (<i>Azadirachta indica</i>)	1.0g	Antibacterial	93
2	Garlic extract (<i>Allium sativum</i>)	0.5g	Antimicrobial	94
3	Aloe vera gel	32ml	Gel base	95
4	Guar gum	1.0g	Increased viscosity and stability	96
5	Honey	2.0ml	Humectant	97
6	Lemon juice	0.5ml	pH control	98
7	Rose water	13.0ml	Vehicle	99

Table No.4: Physical Appearance

Formulation	Colour	Appearance	Consistency	Homogeneity
F1	Light Green	Smooth	Semi-solid	Good
F2	Dark green	Slightly thick	Semi-solid	Good
F3	Green	Thick and glossy	Viscous	Excellent

Table No.5: pH Determination

Formulation	pH Value
F1	6.5
F2	6.2
F3	6.8

Table No.6: Spread-ability

Formulation	Spread-ability (g.cm/sec)
F1	6.8
F2	5.9
F3	4.8

Table No.7: Extrudability

Formulation	Extrudability
F1	Excellent
F2	Good
F3	Moderate

Table No.8: Viscosity

Formulation	Viscosity (cP)
F1	4500
F2	5200
F3	6800

Table No.9: Washability

Formulation	Washability
F1	Easily washable
F2	Easily washable
F3	Slightly difficult

Table No.10: Skin Irritation Test

Formulation	Irritation
F1	None
F2	Mild (due to higher garlic
F3	None

Table No.11: Antimicrobial Activity

Formulation	Zone of Inhibition (mm)
F1	14 mm
F2	18 mm
F3	13 mm

Table No.12: Stability Studies

S.No	Parameter	F1	F2	F3
1	Color change	No	No	no
2	Phase separation	No	No	No
3	pH change	Slight	Slight	Minimal

Table No.13: TLC (Thin Layer Chromatography)

Spot No	Rf Value	Observation
1	0.32	Light yellow spot
2	0.56	Green spot
3	0.74	Dark spot

Table No.14: Column Chromatography

Fraction No	Colour	Activity
F1	Light yellow	Moderate
F2	Dark yellow	High activity
F3	Pale	Low

Table No.15: UV spectrophotometric analysis

Formulation	λ_{max} (nm)	Absorbance
F1	272nm	0.68
F2	275nm	0.85
F3	270nm	0.60



Figure No.1: Azadirachta Indica¹⁷

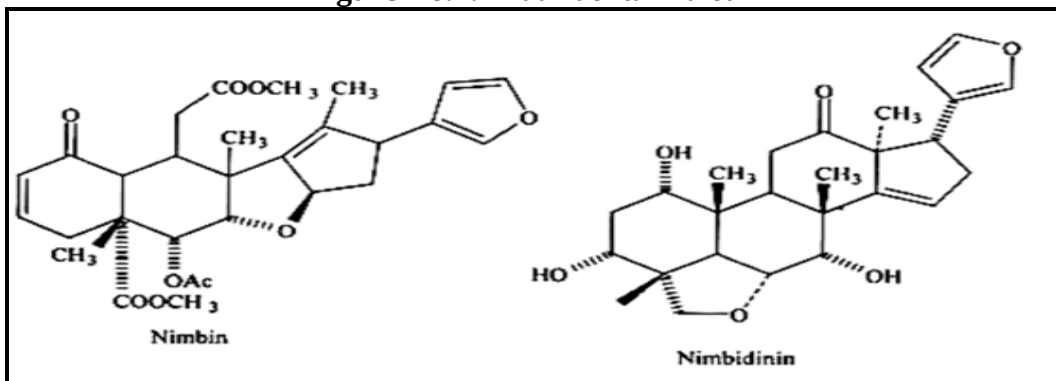


Figure No.2: Structure of Nimbin and Nimbidinin¹⁹



Figure No.3: *Allium sativum*²³

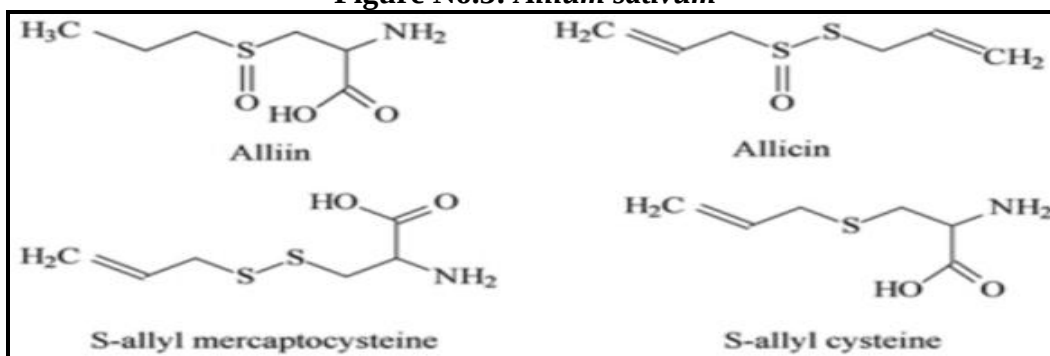


Figure No.4: Structure of S-allyl mercapto cysteine and S-allyl cysteine²⁵



Figure No.5: Formulation F1, F2 and F3



Figure No.6: Formulation of F1

CONCLUSION

The present study successfully focused on the formulation and evaluation of a herbal anti-acne gel containing *Azadirachta indica* and *Allium sativum* as key active ingredients. The use of natural components such as aloe vera, honey, lemon juice and guar gum helped in developing a stable, effective, and patient-friendly topical formulation.

All the prepared formulations (F1, F2 and F3) were evaluated for various physicochemical parameters including appearance, pH, spread-ability, viscosity, extrudability and homogeneity. The results indicated that all formulations possessed acceptable physical characteristics and were suitable for topical application. The pH of the gels was found to be within the normal skin range, confirming their compatibility and safety for human use.

Among the formulations, F1 showed better spread-ability and ease of application, while F3 exhibited higher viscosity and stability. However, F2 demonstrated the highest antimicrobial activity against *Staphylococcus aureus*, which can be attributed to the increased concentration of neem and garlic extracts. This suggests a strong synergistic effect of the herbal ingredients in inhibiting acne-causing microorganisms.

The stability studies revealed that all formulations remained stable under different storage conditions, with no significant changes in color, consistency, or pH. The skin irritation test confirmed that the formulations were safe, with only mild irritation observed in F2 due to higher garlic concentration.

Overall, the study concludes that the formulated herbal anti-acne gel is effective, stable, and safe for topical use. It can serve as a promising alternative to conventional synthetic anti-acne products, which are often associated with side effects. The use of herbal ingredients offers advantages such as better patient compliance, reduced toxicity and cost-effectiveness.

Further studies involving clinical trials on human subjects are recommended to establish the long-term safety and therapeutic efficacy of the formulation.

ACKNOWLEDGMENT

The authors wish to express their sincere gratitude to Suyash Institute of Pharmacy, Hakkabad, Gorakhpur, Uttar Pradesh, India for providing necessary facilities to carry out this research work.

CONFLICT OF INTEREST

We declare that we have no conflict of interest.

REFERENCES

1. Thiboutot D, Gollnick H, Bettoli V, *et al.* New insights into the management of acne: An update from the global alliance, *J Am Acad Dermatol*, 60(5), 2009, S1-S50.
2. Zaenglein A L, Pathy A L, Schlosser B J, *et al.* Guidelines of care for the management of acne vulgaris, *J Am Acad Dermatol*, 74(5), 2016, 945-973.
3. Williams H C, Dellavalle R P, Garner S. Acne vulgaris, *Lancet*, 379(9813), 2012, 361-372.
4. Gollnick H P. From new findings in acne pathogenesis to new approaches in treatment, *J Eur Acad Dermatol Vener*, 29(5), 2015, 1-7.
5. McDowell A, Patrick S. Evaluation of nonculture methods for the detection of *Propionibacterium acnes*, *Clin Microbiol Rev*, 18(2), 2005, 292-305.
6. Kurokawa I, Danby F W, Ju Q, *et al.* New developments in our understanding of acne pathogenesis, *Exp Dermatol*, 18(10), 2009, 821-832.
7. Brook I. Microbiology of acne vulgaris, *J Med Microbiol*, 51(9), 2002, 731-733.
8. Walsh T R, Efthimiou J, Dreno B. Systematic review of antibiotic resistance in acne, *Lancet Infect Dis*, 16(3), 2016, e23-e33.
9. Tan J K, Bhate K. A global perspective on the epidemiology of acne, *Br J Dermatol*, 172(1), 2015, 3-12.
10. Pandey M M, Rastogi S, Rawat A K S. Indian herbal drug for general healthcare, *J Ethnopharmacol*, 147(1), 2013, 1-13.

11. Subapriya R, Nagini S. Medicinal properties of neem leaves: A review, *Curr Med Chem Anticancer Agents*, 5(2), 2005, 149-156.
12. Ankri S, Mirelman D. Antimicrobial properties of garlic (*Allium sativum*), *Microbes Infect*, 1(2), 1999, 125-129.
13. Allen L V. Pharmaceutical dosage forms and drug delivery systems, *Lippincott Williams and Wilkins*, 10th Edition, 2013, 278-280.
14. Aulton M E, Taylor K M G. Aulton's Pharmaceutics: The design and manufacture of medicines, *Elsevier*, 5th Edition, 2018, 392-395.
15. Koul O, Walia S, Dhaliwal G S. Essential oils as green pesticides: Potential and constraints, *Biopestic Int*, 4(1), 2008, 63-84.
16. Biswas K, Chattopadhyay I, Banerjee R K, Bandyopadhyay U. Biological activities and medicinal properties of neem (*Azadirachta indica*), *Curr Sci*, 82(11), 2002, 1336-1345.
17. Pandey G, Verma K K, Singh M. Evaluation of phytochemical and antimicrobial activity of neem leaves, *J Pharmacogn Phytochem*, 9(3), 2020, 1234-1238.
18. Subapriya R, Nagini S. Medicinal properties of neem leaves: A review, *Curr Med Chem Anticancer Agents*, 5(2), 2005, 149-156.
19. Alzohairy M A. Therapeutics role of *Azadirachta indica* (Neem) and their active constituents in diseases prevention and treatment, *Evid Based Complement Alternat Med*, 2016, 2016, 7382506.
20. National Medicinal Plants Board (NMPB), Neem profile, *Government of India*, 2022.
21. Bayan L, Koulivand P H, Gorji A. Garlic: A review of potential therapeutic effects, *Avicenna J Phytomed*, 4(1), 2014, 1-14.
22. Rivlin R S. Historical perspective on the use of garlic, *J Nutr*, 131(3), 2001, 951S-954S.
23. Rahman M S. Allicin and other functional active components in garlic, *J Nutr*, 137(3), 2007, 977S-979S.
24. Shang A, Cao S Y, Xu X Y, et al. Bioactive compounds and biological functions of garlic, *Foods*, 8(7), 2019, 246.
25. Martins N, Petropoulos S, Ferreira I C F R. Chemical composition and bioactive compounds of garlic, *Trends Food Sci Technol*, 56, 2016, 93-102.
26. Directorate of Horticulture, Garlic cultivation statistics, *Government of India*, 2023.
27. Surjushe A, Vasani R, Saple D G. Aloe vera: A short review, *Indian J Dermatol*, 53(4), 2008, 163-166.
28. Eshun K, He Q. Aloe vera: A valuable ingredient for the food, pharmaceutical and cosmetic industries, *Crit Rev Food Sci Nutr*, 44(2), 2004, 91-96.
29. Hamman J H. Composition and applications of Aloe vera leaf gel, *Molecules*, 13(8), 2008, 1599-1616.
30. Ministry of AYUSH, Aloe vera cultivation and uses in India, 2021.
31. Bogdanov S, Jurendic T, Sieber R, Gallmann P. Honey for nutrition and health, *J Am Coll Nutr*, 27(6), 2008, 677-689.
32. National Honey Board, Honey composition and properties, 2022.
33. Da Silva P M, Gauche C, Gonzaga L V, Costa A C O, Fett R. Honey: Chemical composition, stability and authenticity, *Food Chem*, 196, 2016, 309-323.
34. Indian Council of Agricultural Research (ICAR), Honey production in India, 2023.
35. Ghosh S, Sarkar T. Citrus fruits and their health benefits, *J Food Sci Technol*, 58(3), 2021, 1-10.
36. USDA Food Data Central, Lemon juice nutritional profile, 2023.
37. Gonzalez-Molina E, Moreno D A, García-Viguera C. Genotype and harvest time influence on lemon juice compounds, *J Agric Food Chem*, 56(5), 2008, 1669-1675.
38. National Horticulture Board (NHB), Citrus production statistics in India, 2023.
39. Kumar D, Sahu T, Sahu Y. Review on herbal anti-acne gel, *Int J Prog Res Sci Eng*, 5(2), 2024, 45-52.
40. Sharma P, Mishra A, Gupta R. Formulation of herbal anti-acne gel using neem and tea

- tree oil, *Int J Pharm Sci Res*, 6(12), 2015, 5072-5078.
41. Verma S, Singh A. Herbal anti-inflammatory gel using aloe vera and turmeric, *J Pharm Sci Innov*, 5(4), 2016, 120-125.
42. Iqbal Z, et al. Comparative study of salicylic acid and tea tree oil gel, *J Dermatolog Treat*, 29(7), 2018, 1-6.
43. Goyal S, Tiwari R. Herbal gel using manjistha and turmeric, *Int J Green Pharm*, 13(2), 2019, 85-90.
44. Rathod H, Kale R. Formulation of neem, garlic, lemon anti-acne gel, *World J Pharm Res*, 8(9), 2019, 1200-1210.
45. Kale R, Rathod H. Evaluation of herbal gel for oily skin, *Int J Pharm Sci Rev*, 58(1), 2019, 150-156.
46. Taneja A, et al. Herbal gel with Centella asiatica, *J Cosmet Dermatol*, 19(6), 2020, 1500-1506.
47. Patel R, Bhatt N. Comparative study of herbal and synthetic anti-acne gels, *Int J Pharm Sci Res*, 11(4), 2020, 1800-1806.
48. Bansal K, et al. Hydrogel-based herbal delivery system, *Drug Dev Ind Pharm*, 47(5), 2021, 1-9.
49. Mishra N, Tiwari P. Sea buckthorn and aloe vera anti-acne formulation, *Phytother Res*, 36(3), 2022, 1150-1158.
50. Yadav R, Chauhan N. Saffron and sandalwood anti-acne gel, *J Cosmet Dermatol*, 22(4), 2023, 1400-1408.
51. Kulkarni P, et al. Herbal gel with turmeric, honey and cinnamon, *Biomed Pharmacother*, 158, 2023, 114200.
52. Kulkarni P, et al. Clinical evaluation of polyherbal anti-acne gel, *Clin Cosmet Investig Dermatol*, 16, 2023, 245-255.
53. Biswas K, Chattopadhyay I, Banerjee R K, Bandyopadhyay U. Biological activities of neem (*Azadirachta indica*), *Curr Sci*, 82(11), 2002, 1336-1345.
54. Kokate C K, Purohit A P, Gokhale S B. Pharmacognosy, *Nirali Prakashan, Pune*, 56th Edition, 2019, 6.1-6.25.
55. Harborne J B. Phytochemical methods, *Chapman and Hall, London*, 3rd Edition, 1998, 1-32.
56. Ansong J A, Asante E, Johnson R, et al. Formulation and evaluation of herbal anti-acne gel, *Biomed Res Int*, 2023, Article ID: 7838299, 9.
57. Aulton M E, Taylor K M G. Aulton's Pharmaceutics: The design and manufacture of medicines, *Elsevier*, 5th Edition, 2018, 441-456.
58. Lachman L, Lieberman H A, Kanig J L. The theory and practice of industrial pharmacy, *CBS Publishers*, 4th Edition, 2013, 534-563.
59. Montgomery D C. Design and analysis of experiments, *Wiley*, 8th Edition, 2013, 25-40.
60. Creswell J W. Research design: Qualitative, quantitative and mixed methods, *Sage*, 4th Edition, 2014, 155-180.
61. Alzohairy M A. Therapeutics role of neem, *Evid Based Complement Alternat Med*, 2016, 2016, 7382506.
62. Bayan L, Koulivand P H, Gorji A. Garlic therapeutic effects, *Avicenna J Phytomed*, 4(1), 2014, 1-14.
63. Surjushe A, Vasani R, Saple D G. Aloe vera review, *Indian J Dermatol*, 53(4), 2008, 163-166.
64. Mudgil D, Barak S. Guar gum properties, *Int J Biol Macromol*, 62, 2013, 784-789.
65. Bogdanov S, Jurendic T. Honey health benefits, *J Am Coll Nutr*, 27(6), 2008, 677-689.
66. Boskabady M H. Rosa damascena pharmacology, *Iran J Basic Med Sci*, 14(4), 2011, 295-307.
67. Surjushe A. Aloe gel extraction, *Indian J Dermatol*, 53(4), 2008, 163-166.
68. Rowe R C, Sheskey P J. Handbook of pharmaceutical excipients, 6th Edition, 2009, 326-329.
69. Remington: The Science and practice of pharmacy, *Pharmaceutical Press, London*, 23rd Edition, 2020, 1088-1092.

70. Vikas, Jain S K. Textbook of pharmaceutics, Vallabh Prakashan, New Delhi, 5th Edition, 2021, 312-314.
71. Handbook of pharmaceutical excipients, Pharmaceutical Press, London, 9th Edition, 2020, 365-367.
72. Pulok K. Mukherjee. Quality control of herbal drugs, Business Horizons, New Delhi, 2019, 215-218.
73. Vinod D. Rangari. Pharmacognosy and phytochemistry, Career Publications, Pune, 3rd Edition, 2018, 412-415.
74. Gilbert S. Banker and Christopher T. Rhodes. Modern pharmaceutics, CRC Press, New York, 5th Edition, 2020, 678-682.
75. Aulton's Pharmaceutics: The design and manufacture of medicines, Elsevier, 5th Edition, 2018, 742-745.
76. Nadkarni K M. Indian Materia medica, Popular Prakashan, Mumbai, 2019, 85.
77. Kokate C K. Pharmacognosy, Nirali Prakashan, Pune, 52nd Edition, 2019, 214-217.
78. Agrawal S S, Paridhavi. Herbal drug technology, Universities Press, Hyderabad, 2nd Edition, 2018, 302-305.
79. Handbook of pharmaceutical excipients, Pharmaceutical Press, London, 9th Edition, 2020, 298-300.
80. Quality control and standardization of herbal drugs, CBS Publishers, New Delhi, 2020, 190-193.
81. Vinod D. Rangari. Pharmacognosy and phytochemistry, Career Publications, Pune, 3rd Edition, 2018, 418-420.
82. The complete technology book on herbal beauty products, NIIR Project Consultancy Services, Delhi, 2019, 156-160.
83. Giri S, Chakraborty A, Mandal C, et al. Formulation and evaluation of turmeric and neem-based topical nanoemulgel against microbial infection, Gels, 10(9), 2024, 578.
84. Bangar S B, Shreya S B, Vibhute A S, et al. Review on therapeutic approach of anti-acne treatment by *Azadirachta indica* and *Ocimum gratissimum*, World Journal of Advanced, 22(2), 2024, 165-174.
85. Hin K F, Yusof Y A, Salim N, et al. Formulation and characterization of polyherbal anti-acne gel containing Citrus aurantifolia and Aloe barbadensis, Food Research, 6(3), 2023, 45-53.
86. Gulzar B, et al. Preliminary evaluation of the anti-acne potential of herbal extracts against skin pathogens, Journal of Applied Microbiology, 10, 2025, 100339.
87. Shah V D, Dabhi F A, Vasava P. Formulation and evaluation of anti-acne herbal gel using *Moringa oleifera* and Aloe vera, International Journal of Pharmacognosy and Clinical Research, 7(1), 2025, 17-29.
88. Polyherbal antiacne gel: In vitro antibacterial activity and synergistic effects of herbal combinations, Advances in Therapy, 2024.
89. Remington: The science and practice of pharmacy, Pharmaceutical Press, London, 23rd Edition, 2020, 1090-1093.
90. Nadkarni K M. Indian Materia Medica, Popular Prakashan, Mumbai, 2019, 85-88.
91. Kokate C K. Pharmacognosy, Nirali Prakashan, Pune, 52nd Edition, 2019, 214-217.
92. Agrawal S S, Paridhavi. Herbal drug technology, Universities Press, Hyderabad, 2nd Edition, 2018, 300-304.
93. Handbook of pharmaceutical excipients, Pharmaceutical Press, London, 9th Edition, 2020, 298-300.
94. Quality control and standardization of herbal drugs, CBS Publishers, New Delhi, 2020, 188-191.
95. Vinod D. Rangari. Pharmacognosy and phytochemistry, Career Publications, Pune, 3rd Edition, 2018, 418-420.
96. The complete technology book on herbal beauty products, NIIR, Delhi, 2019, 154-158.
97. Vinod D. Rangari. Pharmacognosy and phytochemistry, 400-403.
98. Handbook of pharmaceutical excipients, 310-312.

99. Aulton's pharmaceuticals: The design and manufacture of medicines, *Elsevier*, 5th Edition, 2018, 736-739.
100. Nadkarni K M. Indian Materia Medica, 82-86.
101. Kokate C K. Pharmacognosy, 210-213.
102. Pulok K. Mukherjee. Quality control of herbal drugs, *New Delhi*, 2019, 212-215.
103. Gilbert S. Banker and Christopher T. Rhodes. Modern pharmaceuticals, *CRC Press*, 5th Edition, 2020, 675-678.
104. Remington: The science and practice of pharmacy, 1091-1094.
105. Aulton's Pharmaceuticals, 742-744.
106. Remington: The science and practice of pharmacy, 1102-1104.
107. Alfred Martin. Physical pharmacy, 6th Edition, 512-515.
108. Modern Pharmaceuticals, 689-692.
109. Aulton's Pharmaceuticals, 748-750.
110. Remington: The science and practice of pharmacy, 1095-1097.
111. The complete technology book on herbal beauty products, 160-162.
112. Mukherjee. Quality control of herbal drugs, 220-223.
113. Hugo W B, Russell A D. Pharmaceutical microbiology, 8th Edition, 310-315.
114. ICH Guidelines Q1A(R2) stability testing, 2003, 5-12.
115. Stahl E. Thin layer chromatography: A laboratory handbook, *Springer, Berlin*, 2nd Edition, 2005, 52-86.
116. Snyder L R, Kirkland J J, Dolan J W. Introduction to modern liquid chromatography, *Wiley, New York*, 3rd Edition, 2010, 45-67.
117. Beckett A H, Stenlake J B. Practical pharmaceutical chemistry, *CBS Publishers, New Delhi*, 4th Edition, 2002, 275-310.
118. Barel A O, Paye M, Maibach H I. Handbook of cosmetic science and technology, *CRC Press*, 3rd Edition, 2009, 451-455.
119. Sharma P P. Cosmetics: Formulation, manufacturing and quality control, *Vandana Publications*, 5th Edition, 2014, 312-318.
120. Kokate C K, Purohit A P, Gokhale S B. Pharmacognosy, *Nirali Prakashan, Pune*, 49th Edition, 2014, 3.20-3.45.
121. Deshpande S, Chavan M, Kulkarni P. Polyherbal anti-acne gel formulation, *Int J Pharm Sci Rev Res*, 44(2), 2017, 78-84.
122. Kumar S, Rani R. Evaluation of tulsi and green tea in anti-acne gel, *Asian J Pharm Clin Res*, 10(3), 2017, 200-205.
123. Chanchal D, Swarnlata S. Novel approaches in herbal cosmetics, *Pharmacogn Rev*, 12(24), 2018, 123-128.
124. Mehta D, Joshi V. Aloe vera and calendula gel formulation study, *Int J Cosmet Sci*, 40(5), 2018, 1-7.
125. Khan A, Shaikh S. Personalized herbal anti-acne formulation, *J Ethnopharmacol*, 268, 2021, 113567.

Please cite this article in press as: Faizan Raza et al. Formulation and evaluation of herbal anti acne gel, *International Journal of Research in Pharmaceutical and Nano Sciences*, 15(2), 2026, 56-72.