World Journal of Pharmaceutical Science and Research
www.wjpsronline.com
Research Article
ISSN: 2583-6579
SJIF Impact Factor: 6.916
Year - 2026
Volume: 5; Issue: 5
Page: 718-731

FORMULATION AND CHARACTERIZATION OF MULTILAYER SOAP

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Article Received: 20 March 2026 | | ***Article Revised: 11 April 2026*** | | ***Article Accepted: 01 May 2026***

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DOI: https://doi.org/10.5281/zenodo.20233767

How to cite this Article: Makwana Rajeshree, Panchal Darshita, Soni Jinal, Patel Malav, Prajapati Jay, Patel Mit (2026) FORMULATION AND CHARACTERIZATION OF MULTILAYER SOAP. World Journal of Pharmaceutical Science and Research, 5(5), 718-731.

ABSTRACT

This research presents the development and assessment of a three- layer herbal soap formulated using the melt-and-pour technique. Each layer is uniquely designed to deliver targeted skincare benefits. The base layer, infused with neem (3.5g) exhibits antibacterial and antifungal properties for effective cleansing. The middle layer, containing aloe vera (4ml) and glycerin, provides deep hydration and soothing effects. The top layer, enriched with turmeric (1g) extract and essential oils, enhances skin brightening and imparts a pleasant fragrance. The formulation undergoes rigorous physicochemical, stability, and skin compatibility evaluations to ensure safety and efficacy. Results demonstrates a well-balanced pH (6.57), desirable foamability (5ml) and stability, highlighting its potential as a natural and functional skin care product.

KEYWORDS: Herbal soap, antibacterial, essential oils, antifungal.

1.1 INTRODUCTION

HERBAL SOAP

Herbal soaps have gained significant attention due to their natural composition and skin- friendly properties. Unlike conventional soaps that may contain synthetic chemicals, herbal soaps utilize plant-based ingredients, which are known for their therapeutic and dermatological benefits. The growing consumer preference for natural skincare products has driven innovation in herbal soap formulations, integrating various botanical extracts to enhance cleansing, moisturizing, and healing properties.

The use of medicinal plants in personal care products is an ancient practice backed by modern scientific research. Herbs such as neem (Azadirachta indica) is well-documented for their antibacterial, antifungal, and antiseptic properties, making them effective in cleansing and protecting the skin. Aloe vera (Aloe barbadense) is a well- known natural

moisturizer and skin-soothing agent, commonly used to treat dry and irritated skin. Turmeric (Curcuma longa), rich in curcumin, offers antioxidant and skin-brightening effects, helping to improve skin tone and texture.

The demand for herbal cosmetics has seen a significant rise due to increasing awareness of the potential harmful effects of synthetic chemicals found in traditional personal care products. Consumers are increasingly seeking safer, eco-friendly, and sustainable alternatives. Herbal soaps, being biodegradable and free from harsh detergents, align with these environmental and health-conscious preferences. The incorporation of natural ingredients in personal care products not only ensures gentle cleansing but also reduces the risk of allergies, irritation, and long-term skin damage.

1.2 TYPE OF SOAP

Soaps can be classified based on their composition, intended use, and method of production. The main types include:

1. **Herbal Soaps:** Made from plant-based ingredients, these soaps offer therapeutic benefits such as antibacterial, moisturizing, and soothing properties.
2. **Glycerin Soaps:** These are highly moisturizing and suitable for sensitive or dry skin, as they help retain the skin's natural moisture.
3. **Transparent Soaps:** Typically made with high glycerin content, these soaps have a clear appearance and provide gentle cleansing.
4. **Medicated Soaps:** Formulated with active pharmaceutical ingredients to treat skin conditions like acne, eczema, and fungal infections.
5. **Antibacterial Soaps:** Infused with antimicrobial agents to eliminate bacteria and prevent infections.
6. **Exfoliating Soaps:** Contain natural exfoliants such as oatmeal, coffee, or fruit seeds to remove dead skin cells and promote skin renewal.
7. **Moisturizing Soaps:** Enriched with oils, butter, or glycerin to provide intense hydration.
8. **Beauty Soaps:** Often infused with brightening agents, essential oils, and fragrances to enhance skin appearance and scent.
9. **Handmade Artisanal Soaps:** Crafted using natural ingredients with customized properties, such as essential oils and botanical extracts.
10. **Multilayer Soap:** Soap with multiple distinct layers, often differing in color, ingredients, or properties, for aesthetic appeal or varied skincare benefits.
11. **Whitening Soap:** Claims to lighten skin tone over time.
12. **Baby Soap:** Mild and gentle, formulated for sensitive baby skin.
13. **Aromatic Soap:** Contains essential oils for fragrance and relaxation.
14. **Anti-Aging Soap:** Contains collagen, retinol, or herbal extracts for youthful skin.
15. **Acne-Control Soap:** Includes ingredients like tea tree oil, neem, or salicylic acid.

1.3 Introduction toMultilayer Soap

Multi-layered soaps are an innovative approach in skincare, designed to deliver multiple benefits in a single product. These soaps incorporate different active ingredients in separate layers, ensuring that each layer contributes specific skincare properties while enhancing overall effectiveness. The layering technique allows the integration of various herbal extracts, each addressing a distinct skin concern.

In the case of a three-layer herbal soap, each layer is formulated to serve a unique purpose. The base layer focuses on deep cleansing and antibacterial protection with neem. The middle layer provides hydration and soothing effects using aloe vera and vitamin E. The top layer, enriched with turmeric and essential oils, offers brightening and aromatic benefits. This structured composition ensures that the soap caters to different skin needs simultaneously, providing a holistic skincare solution.

Multi-layered soaps are not only functional but also visually appealing, enhancing consumer interest and market value. Their formulation requires precise layering techniques to maintain structural integrity and prevent separation. The development of such innovative soap formulations aligns with the increasing consumer demand for multi-functional, herbal-based skincare products that are both effective and environmentally friendly.

This study aims to develop and evaluate a three-layer herbal soap with a balanced composition of herbal extracts. The research focuses on ensuring the soap's physicochemical stability, pH balance, foamability, and overall performance. Additionally, skin compatibility tests will be conducted to confirm its safety for regular use. By integrating natural ingredients, this formulation offers a sustainable, skin-friendly alternative to conventional soaps while catering to the growing demand for herbal skincare solutions. The study also aims to contribute to the field of herbal cosmetics by providing scientific validation of the efficacy and benefits of multi-layered herbal soap formulations.

Herbal soaps are gaining popularity as natural skincare alternatives due to their chemical-free formulation and therapeutic benefits. Unlike commercial soaps that contain harsh synthetic ingredients, herbal soaps are formulated using plant-based extracts, essential oils, and natural humectants, offering mild cleansing, moisturizing, and antibacterial effects.

The three-layer herbal soap is designed to provide multi-functional skincare benefits, with each layer containing specific herbal ingredients that target different skin concerns. Ingredients such as neem, aloe vera, turmeric, and rose water contribute to the soap’s antimicrobial, anti-inflammatory, and hydrating properties, making it suitable for all skin types, including sensitive and acne-prone skin.

Multi-layered soaps are not only functional but also visually appealing, enhancing consumer interest and market value. Their formulation requires precise layering techniques to maintain structural integrity and prevent separation. The development of such innovative soap formulations aligns with the increasing consumer demand for multi-functional, herbal-based skincare products that are both effective and environmentally friendly.

1.4 Physiology of Skin

It refers to the study of the skin's structure and functions as the body's largest organ. It serves as a protective shield and plays a crucial role in maintaining overall balance.

1.4.1 Layers of the Skin

The skin consists of three primary layers

a) Epidermis (Outer Layer)

- Acts as a protective barrier.
- Contains keratinocytes, melanocytes (responsible for pigmentation), and immune cells.

- Continuously regenerates new skin cell.

b) Dermis (Middle Layer):

- Composed of collagen and elastin, providing strength and flexibility.
- Houses blood vessels, nerves, sweat glands, and hair follicles.
- Regulates body temperature and sensory perception.

c) Hypodermis (Subcutaneous Layer):

- Made up of fat and connective tissue for insulation and cushioning.
- Supports energy storage and absorbs shock.

1.4.2 Key Functions of the Skin:

- **Protection:** Acts as a barrier against bacteria, viruses, UV radiation, and harmfulchemicals.
- **Sensation:** Contains nerve endings that detect touch, temperature, pain, and pressure.
- **Thermoregulation:** Regulates body temperature through sweat glands and blood vessel dilation/constriction.
- **Water Retention:** Prevents excessive moisture loss and maintains hydration.
- **Vitamin D Synthesis:** Produces vitamin D when exposed to sunlight, essential for bone health.
- **Excretion:** Removes toxins and waste through sweat glands.
- **Immune Defense:** Contains Langerhans cells and other immune components to fight infections.
- **Wound Healing:** Repairs itself through cell regeneration and collagen production.

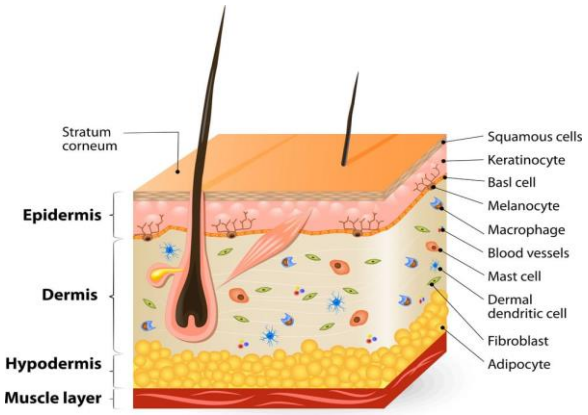

Fig. 1: Layers of skin.

1.5 Mechanism of Soap Action

Multilayer soap primarily works on the epidermis, the outermost layer of the skin. Here's how each ingredient benefits this layer:

- **Neem:** Acts as an antibacterial and antifungal agent, helping to cleanse and protect the skin from infections.
- **Aloe Vera:** Soothes, hydrates, and promotes skin healing, reducing irritation and dryness.
- **Turmeric:** Has anti-inflammatory and brightening properties, helping to reduce blemishes and even out skin tone.

While these ingredients mainly affect the epidermis, their effects can also influence the dermis by promoting deeper hydration, reducing inflammation, and improving skin health over time.

How Multilayer Herbal Soap Helps in Acne Prevention?

1. Top Layer – Neem &Essential oil layer

Main Function: Antibacterial & Anti-inflammatory

Neem: Kills acne-causing bacteria, prevents recurrence.

Lavender/Peppermint Oil: Provides a cooling effect and controls oil production.

Benefit: Helps in preventing and calming active acne.

2. Middle Layer – Aloe Vera & Glycerin Layer

Main Function: Healing & Moisturizing

Aloe Vera: Heals damaged skin, reduces acne scars, and calms irritation.

Glycerin: Maintains moisture balance, keeping skin hydrated without clogging pores.

Benefit: Repairs skin barrier and reduces dryness, which can trigger more acne.

3. Bottom Layer – Turmeric & Rose Water Layer

Main Function: Balancing & Toning

Turmeric: Reduces inflammation, redness, and soothes irritated skin

Rose Water: Acts as a natural toner, tightens pores, and refreshes skin.

Benefit: Tones skin, reduces pore size, and controls oil – preventing further breakouts.

2. MATERIALS AND METHODS[1-3]

2.1. MATERIALS

Table 1: Materials and methods.

Ingredients	Botanical Name	Family	Active Constituents	Pharmacological Actions
Neem	Azadirachta indica	Meliaceae	Nimbin, Nimbidin, Azadirachtin, Flavonoids	Antibacterial, Antifungal, Anti-inflammatory
Aloe Vera	Aloe barbadensis	Asphodelaceae	Aloin, Barbaloin, Polysaccharides, Glycoproteins	Moisturizing, Wound healing, Soothing
Turmeric	Curcuma longa	Zingiberaceae	Curcumin, Demethoxycurcumin, Bisdemethoxycurcumin	Antioxidant, Anti-inflammatory, Skin brightening
Rose Water	Rosa damascena	Rosaceae	Phenolic compounds, Flavonoids, Essential oils	Astringent, Hydrating, Skin toning
Lavender Oil	Lavandula angustifolia	Lamiaceae	Linalool, Linalyl acetate, Cineole	Calming, Antimicrobial, Anti-inflammatory
Soap Base	-	-	-	Cleansing, Foaming
Vitamin-E	-	-	-	Antioxidant, Moisturizing
Alcohol	-	-	-	Layer adhesion

2.1.1 NEEM

Neem (Azadirachta indica) is a widely used medicinal plant in Ayurveda, Unani, and traditional medicine. It possesses antibacterial, antifungal, antiviral, and anti-inflammatory properties, making it an excellent ingredient for herbal soaps.

Fig. 2: Neem.

Pharmacognosy of Neem

1. Botanical Name: Azadirachta indica
2. Family: Meliaceae
3. Parts Used: Leaves, bark, seeds, and oil
4. Active Constituents:

- Nimbin (antibacterial, antifungal)
- Nimbidin (anti-inflammatory)
- Azadirachtin (insecticidal)
- Quercetin (antioxidant)
- Gedunin (antimalarial, antibacterial)
- Limonoids (antimicrobial, skin-protective)

Role of Neem in Herbal Soap

- Antimicrobial Action: Fights bacteria, fungi, and viruses, preventing skin infections.
- Anti-inflammatory Properties: Reduces acne, rashes, and skin irritation.
- Moisturizing Effect: Rich in fatty acids that nourish dry skin.
- Detoxification: Removes toxins and purifies the skin.
- Antioxidant Benefits: Protects skin from free radical damage.

2.1.2 ALEO VERA

Fig. 3: Aloe Vera

Aloe vera (Aloe barbadensis miller) is a well-known medicinal plant used in skincare for its soothing, moisturizing, and healing properties. It is widely incorporated into herbal soaps to treat dry skin, burns, acne, and other dermatological conditions.

Pharmacognosy of Aloe Vera

1. Botanical Name: Aloe barbadensis miller
2. Family: Asphodelaceae (Liliaceae)
3. Parts Used: Gel (found inside the leaves)
4. Active Constituents:

- Aloin & Aloe-Emodin: Anti-inflammatory, antimicrobial
- Polysaccharides (Acemannan): Skin hydration, wound healing
- Salicylic Acid: Acne-fighting, antibacterial
- Vitamins (A, C, E, B12): Antioxidant, skin repair
- Enzymes (Aminases, Catalases, Lipases): Exfoliation, detoxification
- Lignin & Saponins: Deep penetration, cleansing

Role of Aloe Vera in Herbal Soap

- Moisturizing: Hydrates dry and sensitive skin.
- Healing: Promotes wound and burn healing.
- Anti-inflammatory: Reduces redness, irritation, and rashes.
- Antimicrobial: Helps prevent acne and skin infections.
- Cooling & Soothing: Provides relief from sunburns and skin irritation.

2.1.3 TURMERIC

Turmeric (Curcuma longa) is a well-known medicinal herb used in Ayurveda and traditional medicine for its antioxidant, anti-inflammatory, antimicrobial, and skin-brightening properties. It is widely incorporated into herbal soaps to promote healthy skin and treat various dermatological issues.

Fig. 4: Turmeric.

Pharmacognosy of Turmeric

1. Botanical Name: Curcuma longa
2. Family: Zingiberaceae
3. Parts Used: Rhizome
4. Active Constituents:

- Curcuminoids (Curcumin, Demethoxycurcumin,Bisdemethoxycurcumin): Anti-inflammatory, antioxidant, skin-brightening
- Turmerone and Ar-Turmerone: Antimicrobial,wound healing
- Zingiberene: Anti-inflammatory
- Essential Oils: Skin conditioning

Role of Turmeric in Herbal Soap

- Anti-inflammatory: Helps reduce redness, swelling, and irritation.
- Antimicrobial: Prevents bacterial and fungal infections (useful for acne and eczema).
- Antioxidant: Protects against skin damage and premature aging.
- Skin-Brightening: Reduces dark spots, hyperpigmentation, and evens skin tone.
- Wound Healing: Accelerates the healing of cuts, burns, and scars.

REQUIRMENTS: Soap mold, beaker, stirrer, water bath, weighing balance.

2.2 FORMULATION OF MULTILAYER SOAP

1. Preparation of the Soap Base

- Cut the soap base into small pieces.
- Heat it using a double boiler until completely melted.

2. Formation of Layers

I. First Layer (Neem Layer)

- Take ⅓rd. of the melted soap base and add neem extract.
- Mix well and pour it into a soap mold.
- Spray isopropyl alcohol to remove air bubbles.
- Let it partially solidify.

II. Second Layer (Aloe Vera Layer)

- Take another ⅓rd. of the melted soap base and add aloe vera gel and glycerin.
- Mix well and pour over the first layer (ensure the first layer is slightly firm).
- Spray isopropyl alcohol to ensure proper adhesion between layers.

III. Third Layer (Rose Water Layer)

- Take the final portion of the soap base and mix it with turmeric and rose water
- Add lavender essential oil for fragrance.
- Pour it over the second layer and spray isopropyl alcohol.

3. Setting and Demolding

- Allow the soap to cool and harden completely (3–4 hours at roomtemperature).
- Gently remove the soap from the mold.

4. Final Packaging

Fig. 5: Multilayer soap.

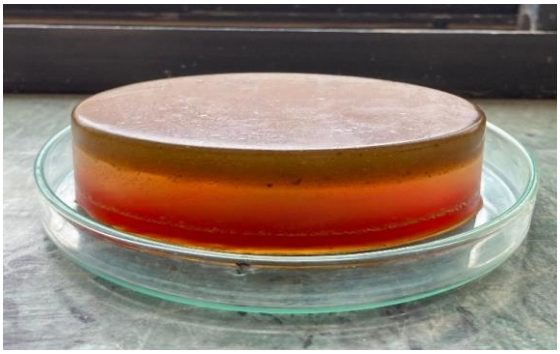

Fig. 6: Packaging.

- Trim edges if needed and wrap the soap in moisture-proof packaging.

2.3 TRIAL BATCHES

Table 3: Trial Batches.

Ingredient	F1 (100ml)	F2 (100ml)	F3 (100ml)	F4 (100ml)	F5 (100ml)	F6 (100ml)
Soap base	95g	95g	95g	95g	95g	95g
Neem powder	7g	-	3.5g	2g	3.5g	5g
Aloe vera gel	3ml	2ml	5ml	3ml	4ml	5ml
Turmeric powder	-	-	-	0.5g	1g	2g
Coffee	-	-	1g	-	-	-
Fuller's Earth clay	-	4g	2g	-	-	-
Rose water	-	-	-	2ml	2ml	2ml
Lavender essential oil	-	-	3-5 drops	1-2 drops	3-5 drops	3-5 drops
Isopropyl alcohol	-	-	-	-	As required	As required

Fig. 7: F1

Fig. 8: F2

Fig. 9: F3

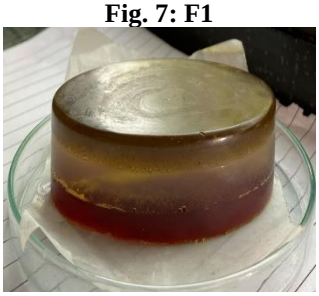

Fig. 10: F4

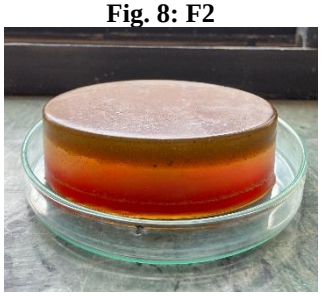

Fig. 11: F5

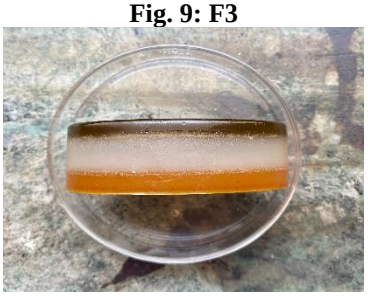

Fig. 12: F6

3. Evaluation Parameters

3.1 Organoleptic Properties

Purpose: To assess the appearance, color, odor, and texture of the soap.

Procedure

1. Visually examine the soap for uniformity of color in each layer.

- Neem – Green
- Aloe Vera – Transparent/light-green
- Turmeric – Yellow

2. Smell each layer to ensure the presence of characteristic herbal fragrances.
3. Touch the surface to evaluate smoothness and absence of cracks.
4. Note any physical defects like layer separation or air bubbles.

Fig. 13: pH

3.2 pH Determination

Purpose: To ensure skin compatibility and mildness.

Procedure

- Weigh 1 g of soap and dissolve it in 10 ml of distilled water.
- Stir the solution and let it stabilize for 5 minutes.
- Measure the pH using a calibrated pH meter.
- Compare with the ideal skin-friendly range (pH: 5.5–7.5).

3.3 Moisture Content

Purpose: To determine water content affecting shelf life and hardness.

Procedure

- Weigh 5 g of soap and place it in a hot air oven at 105°C for 3 hours.
- Cool in a desiccator and weigh again.
- Calculate moisture content using the formula:

$$\% \text{ Moisture} = (\text{Initial weight} - \text{Final weight}) / \text{Initial weight} \times 100$$

- Should ideally be < 10%.

Fig. 14: Antimicrobial Activity.

3.4 Antimicrobial Activity

Purpose: To evaluate antimicrobial efficacy against common pathogens.

Procedure

- Prepare soap extract using 10% w/v solution.
- Conduct agar well diffusion assay against E. coli, S. aureus, and Candida albicans.
- Measure the zone of inhibition (mm) after 24 hours of incubation at 37°C.
- Compare with standard antimicrobial agents.

3.5 Stability Studies

Purpose: To check the soap's physical and chemical stability over time.

Procedure

- Store soap samples at different conditions: Room Temperature (25°C), Accelerated(40°C, 75% RH).

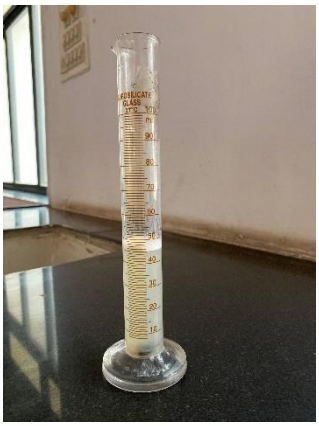

Fig. 15: Foam height.

3.6 Foam Height

Purpose: To measure the vertical height of the foam produced by the soap.

Procedure

- Use the same solution prepared for foam ability.
- Pour into a graduated cylinder and shake for 1 minute.
- Measure the foam height (in cm) immediately after shaking.

3.7 Foam Retention

Purpose: To determine how long the foam remains without collapsing.

Procedure

- Note the time it takes for the foam to reduce to half its initial height.
- Record time intervals every minute.

4. RESULTS

The developed three-layer herbal soap exhibited satisfactory physicochemical characteristics, confirming the successful formulation using the melt-and-pour technique. Visual examination showed clearly defined and stable layers, indicating good interlayer compatibility without diffusion or cracking during storage. The soap demonstrated a uniform texture, acceptable hardness, and an appealing natural appearance, reflecting proper incorporation of herbal ingredients in each layer.

The pH of the formulation was found to be **6.57**, which lies within the ideal range for skin application, suggesting minimal risk of irritation and good skin compatibility. Foamability assessment revealed a foam height of **5 ml**, indicating adequate cleansing efficiency while maintaining mildness. Foam stability was also satisfactory, ensuring consistent performance during use.

Table 4: Results.

Tests	F1	F2	F3	F4	F5(FINAL)	F6
Color	Dark Green	Beige (Earthy)	Beige (Earthy) & dark green	Multicolor	Multicolor	Multicolor
Odor	Bitter	Earthy	Floral & sweet	Floral & sweet	Floral & sweet	Floral & sweet
Texture	Soft	Slightly rough	Smooth	Soft	Smooth	Slightly soft
Appearance	Dull	Opaque	Opaque	Translucent	Shiny	Shiny
pH	6.8	6.29	6.45	6.66	6.57	7.01
Moisture Content	5.93%	2.17%	3.29%	6.32%	3.09%	4.31%
Antimicrobial Activity						
Foam Height(cm)	4.0	3.0	3.5	3.9	5.0	5.7
Foam Retention(mins)	3.0	3.9	2.7	3.0	4.2	4.0
Stability Studies	Stable	Stable	Stable	Stable	Stable	Stable

5. CONCLUSION

The formulated three-layer herbal soap demonstrated promising characteristics both in terms of physical appearance and functional properties. The integration of herbal ingredients like Neem (Azadirachta indica), Aloe vera (Aloe barbadensis miller) and Turmeric (Curcuma longa) was successfully achieved, imparting significant therapeutic benefits to the final product.

Each layer was designed to provide specific skin benefits, the first layer (Neem) contributed antimicrobial and acne-fighting properties. The second layer (Aloe vera) offered moisturizing, soothing and healing effects. The third layer (Turmeric) imparted anti-inflammatory and skin-brightening actions.

Evaluation parameters such as pH (6.57), foamability, foam retention, moisture content and antimicrobial activity were found to be within acceptable limits, suggesting good stability, user compatibility and efficacy. The pH value especially was ideal for maintaining skin health without causing irritation. The soap exhibited good foam height (5 cm), stable foam retention (4.2 minutes) and strong antimicrobial activity, particularly in the Neem layer. Thus, the formulated three-layer herbal soap can be concluded to be a stable, effective and consumer-friendly product suitable for daily use, particularly beneficial for individuals prone to skin infections, acne, dryness and dullness.

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