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Formulation And Evaluation Of Herbal Face Wash: A Comprehensive Review Of Plant-Derived Dermal Therapeutics

[1]Mr.Rushikesh A. Lande,[2]Mr.Aniket R.Gupta, [3]Dr.Vijaykumar Kale, [4]Dr.Mahesh Thakare,[5]Mr.Vaibhav Narwade,

[1]Assistant Professor,Department of Pharmaceutical Chemistry,Kasturi Shikshan Sanstha's College of Pharmacy,Shikrapur, Pune–412208, India,

[2]Student,Kasturi Shikshan Sanstha's College of Pharmacy,Shikrapur, Pune – 412208, India

[3]Principal,Kasturi Shikshan Sanstha's College of Pharmacy,Shikrapur, Pune – 412208, India,

[4]Head of Department,Department of Pharmaceutics,Kasturi Shikshan Sanstha's College of Pharmacy,Shikrapur, Pune –412208,India,

[5]Assistant Professor,Department of Pharmaceutics,Kasturi Shikshan Sanstha's College of Pharmacy,Shikrapur,Pune– 412208, India,

Abstract: The Burden: The maintenance of dermatological health and facial hygiene has become a paramount concern globally, driven by increasing pollution, urbanization, and the prevalence of acne vulgaris and other inflammatory skin conditions. Acne vulgaris alone affects over 85% of the adolescent population globally, necessitating effective daily intervention strategies.

The Gap: Conventional synthetic cleansers, while effective at debris removal, frequently utilize harsh surfactants like sodium lauryl sulfate (SLS) and parabens. These agents are associated with disruption of the stratum corneum barrier, protein denaturation, skin irritation, and long- term cytotoxicity.

The Solution: Herbal face washes, formulated from bioactive plant extracts, offer a promising therapeutic alternative. By leveraging the synergistic effects of natural saponins, essential oils, and tannins, these formulations provide effective cleansing without compromising the skin's natural lipid barrier.

The Mechanism: Key pharmacological actions include bacterial cell wall disruption (antimicrobial), modulation of pro-inflammatory cytokines like NF-kB (antiinflammatory), and scavenging of reactive oxygen species (antioxidant).

The Result: Clinical and formulation studies indicate that standardized herbal face washes demonstrate comparable cleansing efficacy to synthetic counterparts while significantly improving skin hydration, pH balance, and patient compliance due to reduced adverse effects. This review synthesizes contemporary evidence on the formulation, evaluation, and regulatory aspects of herbal dermal therapeutics.

Index Terms **-** Herbal ; Photoprotection; Ultraviolet radiation; Antioxidants; Plant-based cosmetics; Skin protection.

1..INTRODUCTION

1.1 Definition and Scope

A face wash is a foaming or non-foaming cleansing agent specifically designed to remove dead skin cells, oil, dirt, makeup, and other pollutants from the facial epidermis. Unlike bar soaps, which often possess a high pH

(9–10) that can disrupt the skin's acid mantle, face washes are formulated to be pH-balanced (typically 5.5–6.5), ensuring compatibility with the physiological state of the skin.

1.2 Historical Context

The concept of facial cleansing is deeply rooted in traditional systems of medicine. In

Ayurveda, the practice of "Mukha Prakshalana" involved the use of natural cleansers or "Ubtans" made from chickpea flour, turmeric, sandalwood, and milk. These traditional preparations acted as mild exfoliants and antimicrobials. The modern herbal face wash represents a convergence of this ancient wisdom with contemporary cosmetic technology, utilizing standardized extracts in stable gel or cream bases.

1.3 Rationale for Review

With the global rise in pollution-induced skin disorders, there is a critical need to review the scientific formulation of herbal cleansers. The modern consumer is increasingly wary of synthetic chemicals, driving a "green revolution" in the cosmetic industry. This review aims to provide a comprehensive analysis of the ingredients, formulation techniques, and evaluation parameters required to develop a safe and effective herbal face wash, serving as a guideline for pharmaceutical researchers.

2. ANATOMY AND PHYSIOLOGY OF THE SKIN BARRIER

2.1 The Stratum Corneum

The human skin is the body's largest organ, serving as the primary interface between the internal physiological environment and external stressors. The outermost layer, the stratum corneum, functions on the "brick and mortar" model. The "bricks" are corneocytes (dead keratinocytes), and the "mortar" is a complex lipid matrix composed of ceramides, cholesterol, and fatty acids.

Synthetic detergents often strip this lipid matrix, leading to Transepidermal Water Loss (TEWL) and a compromised barrier function. Herbal cleansers aim to remove surface debris while preserving this critical lipid layer.

2.2 The Pilosebaceous Unit

This unit consists of the hair follicle and the sebaceous gland. It is the primary site of acne formation. Under influence from androgens, sebaceous glands produce excess sebum. When this sebum combines with dead skin cells, it blocks the pore, creating an anaerobic environment conducive to the proliferation of Cutibacterium acnes (formerly Propionibacterium acnes).

3. EPIDEMIOLOGY AND MARKET TRENDS

3.1 Global Prevalence of Skin Disorders

Acne vulgaris is the 8th most prevalent disease globally. In India, the prevalence of acne in the age group of 12-25 years is estimated to be approximately 50.6%, highlighting the immense need for effective prophylactic cleansers.

3.2 Market Dynamics

The global shift towards natural personal care is statistically significant.

- **Market Size:** The global herbal beauty products market was valued at approximately USD 97.28 billion in 2025 and is projected to reach USD 151.35 billion by 2034.
- **Growth Rate:** The market is expected to grow at a Compound Annual Growth Rate (CAGR) of 5.0% to 6.1% over the next decade.
- **Consumer Preference:** Surveys indicate that over 45% of women prefer beauty products with "natural" or "organic" labels, driven by awareness.

4. LIMITATIONS OF SYNTHETIC SURFACTANTS

4.1 Sodium Lauryl Sulfate (SLS) Toxicity

SLS is the most common surfactant in commercial face washes due to its high foaming ability. However, it is a potent protein denaturant. It binds to keratin in the skin, causing swelling and irritation. Clinical studies have shown that chronic use of SLS leads to "afterwash tightness" and a significant increase in TEWL.

4.2 Parabens and Preservatives

Methylparaben and propylparaben are widely used to prevent microbial growth in cosmetics. However, they have been detected in breast cancer tissues, raising concerns about their endocrine-disrupting potential. This has led to the "Paraben-Free" movement in the herbal sector.

4.3 Microbial Resistance

The widespread use of synthetic antimicrobials like Triclosan has contributed to crossresistance in bacteria. Staphylococcus aureus strains have shown reduced susceptibility to Triclosan, rendering standard treatments less effective and necessitating the use of complex herbal antimicrobials to which resistance is less likely to develop.

5. PHYTOCHEMISTRY AND BIOACTIVE CONSTITUENTS

Herbal face washes utilize specific classes of secondary metabolites to achieve therapeutic effects.

5.1 Saponins (Natural Surfactants)

Saponins are glycosides found in plants like Sapindus mukorossi (Reetha) and Acacia concinna (Shikakai). They possess amphiphilic properties, meaning they have both hydrophilic and hydrophobic parts. This allows them to form micelles that trap dirt and oil without the aggressive stripping action of synthetic sulfates.

5.2 Flavonoids (Antioxidants)

Polyphenolic compounds, including Quercetin, Kaempferol, and Catechins, are potent antioxidants. They scavenge free radicals generated by UV radiation and pollution, thereby preventing oxidative stress and premature aging of the skin.

5.3 Volatile Oils (Antimicrobials)

Terpenoids found in essential oils such as Tea Tree Oil (Melaleuca alternifolia) and Lemon Oil (Citrus limon) provide broad-spectrum antibacterial and antifungal activity. These lipophilic compounds can easily penetrate the sebaceous follicles to target deep-seated bacteria.

Table 1: Classification of Phytochemicals in Face Washes

Chemical Class	**Key Examples**	**Biological Activity**
Saponins	Reetha, Shikakai	Surfactant, Foaming Agent
Polyphenols	Curcumin, Resveratrol	Anti-inflammatory, Antioxidant
Terpenoids	Azadirachtin, Menthol	Antibacterial, Cooling
Polysaccharides	Acemannan (Aloe)	Humectant, Soothing
Organic Acids	Citric Acid, Salicylic Acid	Exfoliant, pH Adjuster

6. KEY MEDICINAL PLANTS FOR DERMAL APPLICATION

6.1 Neem (Azadirachta indica)

- **Biological Source:** Leaves of *Azadirachta indica* (Family: Meliaceae).
- **Key Constituents:** Azadirachtin, Nimbin, Nimbidin.
- **Mechanism:** Neem is a "pitta pacifier" in Ayurveda. Modern studies show it inhibits the growth of *C. acnes* and *S. epidermis*. It also possesses anti-inflammatory properties that reduce the redness of acne lesions.
- **Use in Formulation:** typically used as a hydro-alcoholic extract (1-2%).

6.2 Turmeric (Curcuma longa)

- **Biological Source:** Rhizomes of *Curcuma longa* (Family: Zingiberaceae).
- **Key Constituents:** Curcuminoids (Curcumin).
- **Mechanism:** Curcumin is a potent COX-2 inhibitor, reducing inflammation. It also inhibits the tyrosinase enzyme, which helps in fading post-acne scars and hyperpigmentation.
- **Synergy:** Often combined with Neem for a synergistic anti-acne effect.

6.3 Aloe Vera (Aloe barbadensis)

- **Biological Source:** Leaves of *Aloe barbadensis* (Family: Asphodelaceae).
- **Key Constituents:** Acemannan, Anthraquinones, Salicylic acid.
- **Mechanism:** It acts as a humectant, retaining moisture in the skin without making it greasy. The polysaccharides stimulate macrophage activity to speed up wound healing.

6.4 Tea Tree (Melaleuca alternifolia)

- **Biological Source:** Leaves of *Melaleuca alternifolia* (Family: Myrtaceae).
- **Key Constituents:** Terpinen-4-ol.
- **Mechanism:** It disrupts the cell membrane of *C. acnes*, causing lysis. It is considered the "Gold Standard" herbal alternative to Benzoyl Peroxide.

6.5 Lemon (Citrus limon)

- **Biological Source:** Fruit peel of *Citrus limon* (Family: Rutaceae).
- **Key Constituents:** Citric acid, Vitamin C, Limonene.
- **Mechanism:** Acts as a natural astringent to remove excess oil. Vitamin C promotes collagen synthesis and brightens the skin.

7. MOLECULAR MECHANISMS OF ACTION

7.1 Bacterial Cell Wall Disruption

The primary mechanism for acne control involves the disruption of the bacterial cell membrane. Phytochemicals like Azadirachtin and Terpinen-4-ol interact with the lipophilic components of the bacterial membrane, increasing permeability. This leads to the leakage of intracellular ions (potassium) and eventual cell death.

7.2 Downregulation of Inflammatory Cytokines

Inflammation in acne is driven by pro-inflammatory cytokines such as Interleukin-6 (IL-6) and Tumor Necrosis Factor-alpha (TNF-alpha). Curcumin and Aloe polysaccharides have been shown to downregulate the NF-κB pathway, a master regulator of inflammation. By inhibiting this pathway, herbal face washes reduce the erythema (redness) and edema (swelling) associated with acne.

7.3 Tyrosinase Inhibition

Post-inflammatory hyperpigmentation (dark spots left after acne) is a major concern. Compounds like Glabridin (from Liquorice) and Vitamin C (from Lemon) inhibit the enzyme tyrosinase, which is responsible for melanin synthesis. This leads to an even skin.

8. FORMULATION DEVELOPMENT: EXCIPIENTS AND BASES

Developing a stable herbal face wash requires a careful balance of active herbal extracts and functional excipients.

8.1 Gelling Agents

Gelling agents provide the necessary viscosity to the formulation.

- **Carbopol 934/940:** Synthetic polymers that create clear, stable gels. They require neutralization with an alkali (like Triethanolamine) to thicken.
- **Xanthan Gum:** A natural polysaccharide gum. It is stable over a wide pH range but may result in a slightly opaque gel.
- **HPMC (Hydroxypropyl Methylcellulose):** Used for creating slime-free, clear gels.

8.2 Humectants

Humectants are hygroscopic substances that prevent the gel from drying out in the tube and help hydrate the skin upon application.

- **Propylene Glycol:** Commonly used at 2-5%.
- **Glycerin:** A natural humectant that attracts water to the skin.

8.3 Preservatives

Since herbal extracts are prone to microbial spoilage, effective preservation is crucial.

- **Methyl Paraben (0.2%) & Propyl Paraben (0.02%):** The standard combination, though controversial.
- **Sodium Benzoate:** An alternative preservative effective in acidic pH.
- **Natural Preservatives:** Essential oils (Rosemary, Neem) can have self- preserving actions.

8.4 Alkalizing Agents

- **Triethanolamine (TEA):** Used drop-wise to adjust the pH of Carbopol gels to 6.0-7.0, triggering the "sol-to-gel" transition.

Table 2: Standard Formula for Herbal Face Wash Gel

Ingredient	**Category**	**Quantity (%)**
Herbal Extract (Neem/Turmeric)	Active Ingredient	1.0 - 5.0 %
Carbopol 940	Gelling Agent	1.0 - 1.5 %
Sodium Lauryl Sulfate (or Saponin)	Surfactant	1.0 - 2.0 %
Propylene Glycol	Humectant	5.0 %

Methyl Paraben	Preservative	0.2 %
Triethanolamine	pH Adjuster	q.s. (approx 1%)
Rose Oil / Lemon Oil	Fragrance	q.s.
Distilled Water	Vehicle	q.s. to 100 %

9. NOVEL DELIVERY SYSTEMS AND ENHANCEMENT

9.1 Phytosomes

Phytosomes are lipid-compatible molecular complexes where water-soluble

phytoconstituents (like flavonoids) are bound to phospholipids (phosphatidylcholine). This structure enhances the penetration of the herbal active through the lipid-rich stratum corneum, significantly increasing bioavailability compared to simple extracts.

9.2 Liposomes

Liposomes are spherical vesicles with a phospholipid bilayer. They can encapsulate both hydrophilic and hydrophobic herbal drugs, protecting them from oxidation and allowing for targeted delivery into the hair follicle.

9.3 Herbal Nanosomes

Nanotechnology in cosmetics involves reducing the particle size of the active ingredient to the nanometer range (10-1000 nm). This massive increase in surface area allows for deeper penetration and prolonged release of the active ingredients.

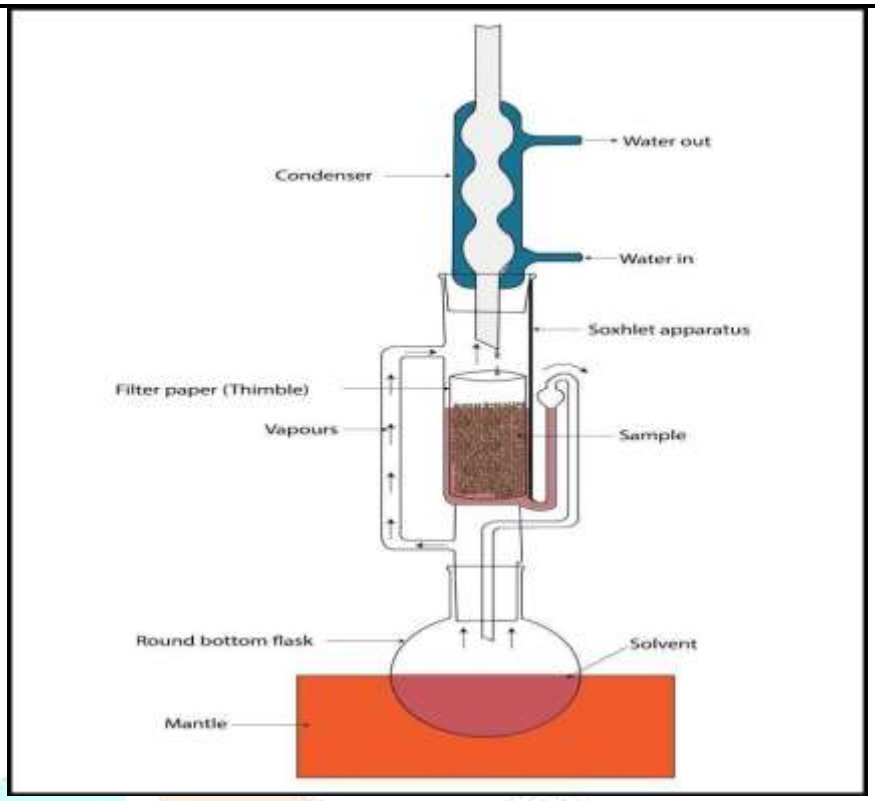
10. METHOD OF PREPARATION (GENERAL REVIEW)

10.1 Extraction (Soxhlet Method)

Before formulation, the active constituents must be extracted from the raw plant material.

The Soxhlet extraction method is commonly used for B.Pharm projects.

- The plant powder is packed in a thimble.
- Solvent (Ethanol/Water) is heated in the flask.
- Vapors rise, condense, and drip through the powder, extracting the actives.
- The cycle repeats until the solvent becomes clear.



10.2 Preparation of the Gel Base

1. **Soaking:** Weigh the required amount of Carbopol 940 and sprinkle it over a measured amount of distilled water. Allow it to swell for 24 hours to ensure complete hydration.
2. **Mixing:** Use a mechanical stirrer to ensure a lump-free dispersion.

10.3 Incorporation of Actives

1. Dissolve the herbal extract in a small quantity of solvent (e.g., propylene glycol or ethanol).
2. Add the preservative (Methyl Paraben) and surfactant (SLS) to the extract solution.
3. Slowly add this mixture to the swollen Carbopol base under continuous stirring.

10.4 Neutralization

1. Add Triethanolamine drop-wise to the mixture.
2. Check the pH continuously. As the pH rises to roughly 6.0-6.5, the mixture will thicken into a transparent gel.
3.

11. EVALUATION PARAMETERS: PHYSICOCHEMICAL

To ensure the quality of the formulated face wash, rigorous testing is required.

11.1 Physical Appearance

The formulation is visually inspected for:

- **Color:** Should be characteristic of the extract (e.g., yellow for turmeric).
- **Clarity:** Gels should ideally be transparent or translucent.
- **Homogeneity:** Absence of lumps or aggregates.

12.2 pH Determination

The pH is crucial for skin compatibility.

- **Procedure:** Dissolve 1g of gel in 100ml of distilled water (1% solution). Dip the electrode of a digital pH meter into the solution.
- **Standard:** The acceptable range is 5.5 to 7.0.

11.3 Viscosity and Rheology

Viscosity determines the spreadability and flow of the product.

- **Procedure:** Use a Brookfield Viscometer (Spindle no. 64 at 10-50 rpm).
- **Requirement:** The gel should exhibit pseudoplastic (shear-thinning) flow, meaning it becomes thinner when rubbed on the face but stays thick in the tube.

11.4 Spreadability

- **Procedure (Parallel Plate Method):** Place 1g of gel between two horizontal glass slides (20x20 cm). Place a standard weight (125g) on the upper slide for 1 minute to compress the gel. Remove the weight and measure the time taken for the upper slide to separate from the lower slide.
- **Formula:** $S = M \times L / T$ (where M = weight tied to upper slide, L = length of slide, T = time taken).

11.5 Foamability

- **Procedure (Cylinder Shake Method):** Take 50ml of a 1% formulation solution in a graduated cylinder. Cover the top and shake vigorously for 1 minute. Record the volume of foam immediately and after 5 minutes to check foam stability.

11.6 Washability

- **Procedure:** Apply the gel to the skin and rinse with water. Note the ease of removal and whether any greasy residue remains.

12. EVALUATION PARAMETERS: ANTIMICROBIAL AND SAFETY

12.1 Zone of Inhibition (Agar Well Diffusion)

This test measures the ability of the face wash to kill bacteria.

- **Procedure:** Prepare nutrient agar plates seeded with *Staphylococcus aureus* or *Propionibacterium acnes*. Punch wells into the agar and fill them with the herbal face wash. Incubate at 37°C for 24 hours.
- **Observation:** Measure the diameter of the clear zone (Zone of Inhibition) around the well. A zone >15mm usually indicates good antimicrobial activity.

12.2 Irritancy Test (Patch Test)

- **Procedure:** Apply the gel to a marked area (1 sq. cm) on the dorsal surface of the left hand. Cover with a bandage for 24 hours.
- **Observation:** Inspect for Erythema (redness) or Edema (swelling).
- **Scoring:** 0 = No reaction, 1 = Slight redness, 2 = Moderate redness, 3 = Severe irritation.

13. STABILITY STUDIES AND ICH GUIDELINES

Herbal products are susceptible to environmental degradation. Stability testing ensures the product remains effective throughout its shelf life.

13.1 ICH Q1A (R2) Guidelines

Accelerated stability testing is conducted to predict the shelf life.

- **Storage Conditions:** Samples are stored in stability chambers at:
  - *Temperature: 40°C ± 2°C*
  - **Humidity:** 75% RH ± 5% RH
- **Duration:** 1, 2, and 3 months (and up to 6 months for intermediate testing).

13.2 Parameters Monitored

Samples are withdrawn at intervals (e.g., 30, 60, 90 days) and tested for:

- **pH Drift:** Significant changes indicate chemical instability.
- **Syneresis:** Separation of the liquid phase from the gel.
- **Color Change:** Oxidation of herbal extracts often causes darkening.
- **Microbial Growth:** Checking for contamination.

Table 3: Sample Stability Observation Format

Parameter	Initial (0 Month)	1 Month (40°C)	2 Months (40°C)	3 Months (40°C)
Color	Yellow	Yellow	Yellow	Slight Darkening
pH	6.5	6.4	6.4	6.3
Viscosity	2000 cps	1980 cps	1950 cps	1920 cps
Separation	None	None	None	None

14. STANDARDIZATION AND REGULATORY ASPECTS

14.1 Standardization of Extracts

Using raw "extracts" can lead to batch-to-batch variation. Modern standardization requires quantifying specific marker compounds using HPLC (High-Performance Liquid Chromatography) or HPTLC.

- *Example:* A Turmeric extract should be standardized to contain >95% Curcuminoids.

14.2 Regulatory Compliance (India)

In India, herbal cosmetics are regulated under the Drugs and Cosmetics Act, 1940.

- **BIS Standards:** The Bureau of Indian Standards (BIS) sets limits for heavy metals (Lead < 20 ppm, Arsenic < 2 ppm) and microbial counts in cosmetics.
- **Labeling:** Labels must disclose all active ingredients and preservatives.

15. CONCLUSIONS AND FUTURE PERSPECTIVES

15.1 Summary of Evidence

The formulation of herbal face wash represents a synergistic approach to skincare. Scientific evidence reviewed herein confirms that phytochemicals like curcumin, azadirachtin, and acemannan provide robust antimicrobial, anti- inflammatory, and antioxidant benefits. When formulated in a standardized gel base, these agents offer cleansing efficacy comparable to synthetic surfactants but with a superior safety profile, characterized by reduced irritation and enhanced skin hydration.

15.2 Future Directions

- **Polyherbal Formulations:** Future research should explore the synergistic potential of combining 3 or more herbs (e.g., Neem + Turmeric + Tulsi) to target multiple acne pathways simultaneously.
- **Green Synthesis:** Developing "waterless" cleansers and using biodegradable packaging to reduce the environmental footprint.
- **Clinical Trials:** There is a need for more rigorous, randomized controlled trials on human subjects to validate the long-term efficacy of these herbal formulations compared to dermatological gold standards like Benzoyl Peroxide.

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