Kavya Setu
A Multidisciplinary Open Access, Peer-Reviewed Refereed Journal
Impact Factor: 7.2 ISSN No: 3049-4176

Formulation, Physicochemical Characterization and Optimization of a Herbal Paraben-Free Face Wash Using Selected Botanical Extracts

Souravh Jha
Research Scholar, Department of Pharmacy, Monad university
Dr. Yesh Pratap Singh Rana
Professor, Department of Pharmacy, Monad university

ABSTRACT

The increasing interest in plant-based personal-care products has encouraged the development of facial cleansing formulations that combine effective cleansing with desirable sensory characteristics, skin compatibility, and appropriate microbiological protection. The present research paper focuses on the systematic formulation, physicochemical characterization, and optimization of a herbal paraben-free face wash containing selected botanical extracts. The study is designed around the premise that the development of a successful herbal cleanser requires more than simply replacing synthetic ingredients with plant-derived materials. The botanical components, surfactant system, viscosity modifier, humectant, preservation-supporting system, pH modifier, fragrance, and aqueous vehicle must function together without compromising cleansing performance, stability, appearance, or user acceptability.

Selected botanical materials are considered on the basis of their traditional relevance, phytochemical characteristics, reported antioxidant and antimicrobial potential, skin-conditioning properties, availability, and compatibility with the formulation. Extracts are prepared using an appropriate extraction procedure and subjected, where applicable, to preliminary phytochemical characterization. Several experimental batches are proposed by systematically varying herbal-extract and surfactant concentrations while maintaining appropriate formulation controls. The formulations are evaluated for organoleptic characteristics, homogeneity, pH, viscosity, spreadability, foamability, foam stability, washability, and cleansing efficiency. Optimization is undertaken by considering the collective performance of these parameters rather than relying on a single quality attribute.

Particular attention is given to the relationship between surfactant concentration and cleansing behaviour. Although surfactants are essential for soil removal and micelle formation, excessive surfactant exposure can adversely affect skin barrier characteristics and may increase the likelihood of dryness or irritation.

Keywords: herbal cosmetics; paraben-free; face wash; botanical extracts; surfactants; formulation optimization; physicochemical evaluation; cleansing efficiency; viscosity; pH; foaming; skin compatibility.

1. INTRODUCTION

1.1 Background

Cosmetic products have progressively moved from simple preparations intended primarily for cleansing or beautification toward multifunctional products designed to address hygiene, sensory experience, skin conditioning, environmental exposure, and consumer expectations. Facial cleansers occupy an important position within this category because cleansing represents one of the most frequent components of routine skin care. A facial cleanser must remove unwanted substances from the skin surface while avoiding excessive disruption of the physiological barrier.

Facial skin is continuously exposed to sebum, perspiration, environmental particulate matter, microorganisms, atmospheric pollutants, dead corneocytes, and cosmetic residues. These materials may interact with one another and with the skin surface, making their removal dependent on the physicochemical characteristics of the cleansing system. Water alone is insufficient for removing many hydrophobic materials, particularly sebum and oily cosmetic residues. Surfactants therefore play a central role in modern facial cleansing formulations because they reduce interfacial tension and facilitate incorporation and removal of oily soils into aqueous systems.

Nevertheless, the term “herbal” does not automatically imply superior safety, stability, or efficacy. Plant extracts can vary according to species, geographical origin, harvesting conditions, plant part, extraction solvent, extraction temperature, storage, and standardization. Botanical materials can also introduce colour, odour, insoluble material, reactive compounds, or microbial contamination into a formulation. Therefore, formulation development must integrate botanical science with cosmetic technology.

Another important consideration is the preservation system. Aqueous cosmetic formulations provide a potentially favourable environment for microbial growth. Conventional preservatives such as parabens have historically been used because of their antimicrobial effectiveness, broad formulation applicability, and relatively established technological performance. Nevertheless, consumer demand for “paraben-free” products has stimulated investigation of alternative preservation strategies. The scientific challenge is not simply to remove parabens but to replace their preservative function with a system that provides adequate microbiological control without producing unacceptable irritation, instability, odour, or incompatibility.

1.2 Scientific Basis of Facial Cleansing

The skin surface contains both hydrophilic and lipophilic materials. Sebum, cosmetic oils, particulate contaminants and some environmental pollutants are poorly soluble in water. Surfactants address this problem by possessing both hydrophilic and hydrophobic structural regions. Above the critical micelle concentration, surfactant molecules can aggregate into micelles or related assemblies, allowing hydrophobic materials to become associated with the

Kavya Setu
A Multidisciplinary Open Access, Peer-Reviewed Refereed Journal
Impact Factor: 7.2 ISSN No: 3049-4176

interior or hydrophobic regions of the aggregates while the hydrophilic portions remain associated with the aqueous phase.

The cleansing process can therefore be viewed as a sequence involving:

1. wetting of the skin surface;
2. interaction between the cleanser and surface soil;
3. reduction of interfacial forces;
4. emulsification or solubilization of hydrophobic material;
5. dispersion of soil within the cleansing medium; and
6. removal of the dispersed material during rinsing.

1.3 Herbal Approach to Facial Cleansing

Botanical extracts may be incorporated into a cleanser for purposes extending beyond simple cleansing. Their potential contribution can be associated with the phytochemical constituents present in the selected plant.

For example, phenolic compounds and flavonoids are frequently investigated because of their radical-scavenging and reducing properties. Certain plant-derived compounds also exhibit antimicrobial activity under specific experimental conditions. Aloe vera is widely investigated in dermatological and cosmetic contexts because of its polysaccharide-rich gel and associated skin-conditioning properties. Neem has traditionally been used in skin-related preparations and contains numerous biologically active constituents. Tulsi contains volatile and phenolic constituents of interest in antimicrobial and antioxidant research, whereas turmeric is particularly associated with curcuminoids and other compounds with antioxidant and anti-inflammatory research interest.

1.4 Paraben-Free Formulation Concept

A paraben-free formulation is defined operationally in the present research as a formulation developed without intentional incorporation of parabens as the primary conventional preservative system. This definition should not be interpreted as a claim that all parabens are intrinsically unsafe or that every alternative preservative is automatically safer.

1.5 Formulation Optimization

Optimization refers to the systematic identification of a formulation composition that provides an acceptable balance among competing quality characteristics.

For a face wash, the optimum formulation should ideally demonstrate:

- Appropriate ph;
- Satisfactory cleansing;
- Acceptable viscosity;
- Adequate spreadability;
- Desirable foam formation;
- Satisfactory foam persistence;
- Easy rinsing;

- Homogeneous appearance;
- Acceptable colour and odour;
- Appropriate skin feel;
- Microbiological quality;
- Preservation adequacy; and
- Acceptable storage stability.

These characteristics may conflict. Increasing surfactant concentration may improve cleansing or foam but may negatively influence mildness. Increasing thickener concentration may improve viscosity but reduce spreadability or alter foam behaviour. Increasing herbal extract concentration may strengthen the botanical profile while simultaneously increasing colour intensity, odour, sedimentation risk, or viscosity changes. Optimization therefore requires consideration of the formulation as an integrated system.

1.6 Aim of the Study

The aim of the study is:

To formulate, physicochemically characterize, and optimize a herbal paraben-free face wash containing selected botanical extracts with satisfactory cleansing, formulation, sensory, and stability-related characteristics.

1.7 Objectives of the Study

The study is designed to achieve the following objectives:

- ❖ To select suitable botanical ingredients for incorporation into a herbal facial cleansing formulation.
- ❖ To prepare appropriate herbal extracts using a reproducible extraction procedure.
- ❖ To formulate different batches of paraben-free herbal face wash by varying relevant formulation components.
- ❖ To evaluate the organoleptic and physicochemical characteristics of the developed formulations.
- ❖ To investigate the influence of herbal-extract concentration on formulation characteristics.
- ❖ To investigate the influence of surfactant concentration on cleansing and foaming behaviour.
- ❖ To evaluate pH, viscosity, spreadability, foamability, foam stability, washability, and cleansing performance.
- ❖ To compare the experimental batches using predefined quality attributes.
- ❖ To identify the formulation showing the most balanced overall performance.
- ❖ To establish a scientifically justified basis for further stability, microbiological, skin-compatibility, and consumer evaluation.

1.8 Research Hypotheses

Null Hypothesis (H_0)

Variation in the concentrations of selected herbal extracts and formulation components will not produce statistically meaningful differences in the physicochemical and functional characteristics of the developed face-wash formulations.

Alternative Hypothesis (H_1)

Variation in the concentrations of selected herbal extracts and formulation components will produce statistically meaningful differences in one or more physicochemical and functional characteristics of the developed face-wash formulations, enabling identification of an optimized formulation.

A secondary formulation hypothesis may be stated as:

H_{12}: An appropriately balanced herbal paraben-free face-wash formulation can achieve satisfactory cleansing and physicochemical characteristics without requiring incorporation of parabens.

Botanical selection
↓
Authentication and processing of plant materials
↓
Extraction and preliminary phytochemical characterization
↓
Selection of surfactant and supporting excipients
↓
Preparation of experimental formulations
↓
Variation of herbal-extract/surfactant concentrations
↓
Physicochemical evaluation
↓
Cleansing + foaming + spreadability + rheological assessment
↓
Comparative statistical analysis
↓
Optimization of formulation
↓
Selection of best-performing herbal paraben-free face wash

Figure 1. Conceptual framework

2. REVIEW OF LITERATURE

2.1 Herbal Cosmetics and Modern Facial Cleansing

Herbal cosmetics occupy an intermediate position between traditional plant-based preparations and scientifically standardized cosmetic products. Traditional systems have historically used botanical materials for cleansing, fragrance, soothing, conditioning, and treatment-oriented purposes. Modern cosmetic science has expanded this approach by applying extraction technology, phytochemical characterization, quality control, formulation science, microbiological testing, and stability assessment.

The scientific value of herbal cosmetics lies in the chemical diversity of plants. However, this diversity can also become a source of formulation variability. A plant extract is not a single chemical entity. It may contain numerous compounds with different solubilities, polarities, molecular sizes, reactivities, and stability profiles. Consequently, the performance of an herbal cosmetic cannot be predicted solely from the identity of the plant.

2.2 Botanical Ingredients Relevant to Skin Care

Aloe vera

Aloe vera has attracted substantial interest in dermatological and cosmetic research. The leaf contains a gel fraction characterized by polysaccharides, together with other compounds present in varying amounts depending on processing and preparation. Aloe-based materials have been investigated for moisturizing, soothing, wound-related and skin-conditioning applications.

For a facial cleanser, Aloe vera is potentially valuable as a skin-conditioning component. Nevertheless, processing is important because the composition of Aloe preparations can differ substantially depending on whether whole-leaf material, inner-leaf gel, decolorized gel, or another preparation is used.

Neem

Azadirachta indica has a long history of traditional use in South Asian health practices. Neem leaves and other plant parts contain numerous limonoids, flavonoids and other compounds. Research has investigated antimicrobial, antioxidant and anti-inflammatory properties of neem-derived materials.

In a cleanser, neem extract may provide a botanical functional component, particularly where antimicrobial and antioxidant characteristics are being investigated. However, neem extract may also influence product colour and odour and therefore requires careful concentration control.

Tulsi

Ocimum tenuiflorum (syn. *Ocimum sanctum*) is traditionally used in Indian systems of medicine. Its phytochemical profile includes phenolic constituents and volatile compounds, with eugenol being among the constituents frequently discussed in the literature.

Tulsi is relevant to herbal cosmetic formulation because of research interest in its antioxidant and antimicrobial properties. The concentration used in a cleanser should be balanced against possible fragrance intensity and formulation compatibility.

Turmeric

Kavya Setu
A Multidisciplinary Open Access, Peer-Reviewed Refereed Journal
Impact Factor: 7.2 ISSN No: 3049-4176

Curcuma longa is particularly associated with curcuminoids, including curcumin. Curcuminoids have been widely investigated for antioxidant and anti-inflammatory properties. Turmeric presents a distinctive formulation challenge because curcuminoids are strongly coloured and have limited water solubility. Their incorporation can therefore substantially influence product colour and may require suitable extraction or dispersion approaches.

2.3 Surfactants in Facial Cleansers

Surfactants constitute the functional core of most face-wash systems. They reduce surface and interfacial tension and facilitate removal of oily and particulate material.

Surfactants can broadly be categorized as:

Surfactant class	General characteristic	Formulation relevance
Anionic	Strong cleansing and foaming potential	Effective but selection must consider mildness
Cationic	Positively charged	Less common as primary facial cleansing surfactants
Non-ionic	Generally mild and versatile	Useful for mild cleansing and solubilization
Amphoteric	Charge behaviour depends on conditions	Frequently useful in mild cleanser systems

The selection of a surfactant should not be based exclusively on foam volume. Foam can influence consumer perception, but high foam does not necessarily indicate superior cleansing. A formulation that produces abundant foam but leaves excessive dryness may be less suitable for routine facial use than a lower-foaming but milder cleanser.

2.4 pH and Skin Compatibility

Skin surface pH is an important consideration in cleanser development. The skin normally possesses a mildly acidic surface environment, often referred to as the acid mantle. Excessive deviation from physiological conditions may affect barrier-associated processes and microbial ecology.

For this reason, a face wash should be formulated with a carefully selected pH rather than simply targeting neutral pH. The optimum pH is influenced by the surfactant system, preservative system, botanical extracts, and intended skin application.

2.5 Viscosity and Rheological Properties

Viscosity determines how a liquid or gel flows under applied force. In a face wash, viscosity affects:

- Ease of dispensing;

- Product retention on the hand;
- Spreading across the face;
- Sensory perception;
- Packaging performance; and
- Consumer perception of product quality.

2.6 Foaming Characteristics

Foam formation is strongly influenced by surfactant type, concentration, water quality, viscosity, temperature, and formulation additives. Consumer expectations can make foam an important sensory characteristic, particularly in cleansing products.

Nevertheless, foam height is an imperfect proxy for cleansing efficacy. A product can generate substantial foam while providing inadequate removal of specific oily soils, whereas some mild cleansing systems may produce moderate foam but perform effectively.

2.7 Spreadability and Washability

Spreadability represents the ease with which a formulation can be distributed over the skin surface. For a facial cleanser, adequate spreadability can facilitate uniform contact and reduce the quantity required for application.

Washability represents the ease with which the product can be removed during rinsing. Excessive residual material can result in an undesirable film or skin feel, while insufficient conditioning may contribute to perceived tightness or dryness.

2.8 Cleansing Efficiency

Cleansing efficiency can be assessed through controlled removal of a standardized soil from a test substrate. A suitable artificial sebum-like mixture can be used to provide reproducible contamination. The amount of soil removed before and after application can then be quantified using an appropriate analytical approach.

The major advantage of a standardized cleansing model is reproducibility. However, artificial soil does not completely reproduce the complexity of human facial sebum, sweat, corneocytes, cosmetics, and environmental particles. Consequently, laboratory cleansing results should be interpreted as controlled performance measures rather than complete representations of real-world skin cleansing.

3. RESEARCH METHODOLOGY

3.1 Research Design

The study follows an experimental formulation-development design consisting of:

1. selection and authentication of botanical materials;
2. preparation of extracts;
3. preliminary phytochemical characterization;
4. selection of formulation excipients;
5. preparation of experimental batches;
6. physicochemical evaluation;

7. comparative analysis;
8. optimization; and
9. selection of the best-performing formulation for subsequent investigation.

3.2 Study Materials

The formulation may incorporate selected botanical extracts such as Aloe vera, neem, tulsi, turmeric, or other botanicals selected according to the actual experimental design. The final thesis should list the **exact botanical species, plant part, extraction solvent, supplier/source, batch number, and authentication details actually used**.

Table 1. Proposed categories of formulation materials

Material category	Examples	Primary function
Botanical extract	Aloe vera/neem/tulsi/turmeric extract	Herbal functional component
Primary/mild surfactant	Selected anionic, non-ionic or amphoteric surfactant	Cleansing
Humectant	Glycerol or another suitable humectant	Moisture retention and skin feel
Thickener	Suitable polymer/natural thickener	Viscosity adjustment
Chelating agent	Suitable cosmetic chelator, where applicable	Supports formulation stability/preservation
Alternative preservation system	Validated non-paraben system	Microbial control
pH modifier	Appropriate acid/base	pH adjustment
Fragrance	Cosmetic-grade fragrance, if used	Sensory acceptability
Purified water	Purified/deionized water	Vehicle

3.3 Selection and Authentication of Botanical Materials

Botanical materials should be selected according to:

- Documented traditional use;
- Relevant phytochemical constituents;
- Evidence of skin-related biological activity;
- Availability;
- Sustainability;
- Formulation compatibility;
- Extraction feasibility; and
- Safety considerations.

3.4 Preparation of Herbal Extracts

The selected plant material should be cleaned, dried where appropriate, and pulverized into a relatively uniform particle size. The extraction solvent should be selected according to the polarity and stability of the desired constituents.

3.5 Preliminary Phytochemical Screening

Qualitative phytochemical screening may be conducted to identify broad classes of constituents. Tests may include procedures for:

- Alkaloids;
- Flavonoids;
- Phenolics;
- Tannins;
- Saponins;
- Terpenoids;
- Glycosides; and
- Steroids.

3.6 Formulation Development

Experimental formulations should be designed by changing selected formulation variables while controlling the remaining components.

Table 2. Illustrative formulation-development design

Batch	Herbal active level	Surfactant level	Intended purpose
F1	Low	Moderate	Examine lower botanical loading
F2	Moderate	Moderate	Examine balanced botanical loading
F3	High	Moderate	Examine higher botanical loading
F4	Optimized combination	Optimized	Final candidate formulation
Control/base	No herbal active	Defined base	Baseline comparison

Important: The actual concentrations must be determined from preliminary compatibility, safety, formulation and optimization studies. The table is a **study-design framework**, not experimental data.

3.7 Manufacturing Procedure

The manufacturing procedure should be performed using a standardized sequence.

General sequence

Purified water preparation

↓

Dissolution/dispersal of water-soluble components

↓

Preparation of thickener phase
↓
Controlled addition of surfactants
↓
Incorporation of botanical extracts
↓
Addition of preservation-supporting system
↓
pH adjustment
↓
Addition of fragrance, where applicable
↓
Gentle homogenization
↓
Deaeration
↓
Filling into compatible containers

Excessive agitation should be avoided because it can introduce air and produce misleading differences in foam characteristics.

3.8 Organoleptic Evaluation

The formulations should be evaluated for:

- colour;
- odour;
- appearance;
- texture;
- homogeneity; and
- presence or absence of visible particles or phase separation.

3.9 pH Determination

pH should be determined using a properly calibrated digital pH meter. The electrode should be suitable for the formulation matrix. Replicate measurements should be performed under controlled temperature conditions.

The measured pH should be interpreted in relation to:

1. intended facial use;
2. surfactant stability;
3. botanical-extract stability;
4. preservation requirements; and
5. skin compatibility.

3.10 Viscosity and Rheology

Viscosity should be measured using a suitable rotational viscometer or rheometer. Instrument type, spindle or geometry, rotational speed, sample volume, and temperature should be documented.

Measurements should be repeated to assess reproducibility.

3.11 Spreadability

Spreadability may be evaluated using a standardized laboratory method appropriate for semiliquid cosmetic formulations. The test should measure the ease with which a defined quantity of formulation spreads under controlled conditions.

3.12 Foamability and Foam Stability

A standardized foam test should be applied to all batches.

Possible measurements include:

- initial foam height;
- foam height after a defined period;
- percentage foam retention; and
- qualitative foam character.

The method should be kept identical between batches because foam results are strongly method dependent.

3.13 Cleansing Efficiency

A controlled artificial-soil removal model should be employed. A standardized sebum-like soil may be applied to an appropriate substrate and allowed to equilibrate.

3.14 Washability and Skin Feel

Washability should be evaluated by observing:

- ease of rinsing;
- residual film;
- slipperiness;
- perceived cleanliness; and
- post-rinse feel.

3.15 Optimization Strategy

Optimization should not simply select the batch with the highest foam or highest cleansing score. A weighted decision framework may be applied.

Table 3. Proposed optimization matrix

Quality attribute	Desired direction	Relative importance
Appearance	Acceptable and homogeneous	High
pH	Suitable for facial application	High
Viscosity	Moderate/appropriate	High
Spreadability	Higher within acceptable range	Moderate–high
Foamability	Adequate	Moderate

Foam stability	Adequate	Moderate
Cleansing efficiency	High	Very high
Washability	Easy	High
Skin feel	Comfortable	High
Stability	Maintained during storage	Very high

4. RESULTS AND INTERPRETATION

The organoleptic evaluation should establish whether the incorporation of botanical extracts produces unacceptable changes in the physical appearance of the face wash. Differences in colour among formulations would be expected when botanical concentration varies, particularly when strongly pigmented extracts are incorporated. Turmeric-derived material, for example, may contribute a yellow to yellow-orange appearance, whereas neem or other green botanical materials may influence colour differently.

Odour should be interpreted cautiously because botanical extracts and essential oils may contribute characteristic aromas. A strong botanical odour is not necessarily a formulation defect, but an intensity that interferes with consumer acceptability may indicate a need for concentration adjustment or fragrance balancing.

4.2 Physicochemical Characteristics

The physicochemical results should be interpreted collectively. A formulation showing an appropriate pH but poor viscosity cannot automatically be considered optimized. Similarly, high cleansing efficiency accompanied by undesirable washability or excessive viscosity may limit practical suitability.

The pH values should be assessed against the predetermined target range for the intended facial application. Differences between batches may arise from botanical acids, alkaline constituents, surfactant systems, or pH-adjusting agents.

Viscosity should be interpreted in relation to application characteristics. A moderate increase in viscosity may improve product handling and reduce uncontrolled runoff, whereas excessive viscosity may impair spreading and dispensing.

Changes in spreadability may be associated with viscosity and polymer concentration. In general, formulations with excessively high viscosity may require greater mechanical force during spreading, while very low viscosity may result in poor product retention.

Foam behaviour should be considered separately from cleansing efficiency. A formulation that produces moderate foam can still provide satisfactory cleansing if the surfactant system effectively interacts with the target soil.

5. DISCUSSION AND CONCLUSION

5.1 Discussion

The development of a herbal paraben-free face wash represents a formulation challenge involving multiple interacting variables. The scientific value of the present work lies in treating the product as an integrated system rather than considering herbal ingredients, surfactants, viscosity, pH, and cleansing performance independently.

Botanical extracts can contribute desirable functional characteristics, but their incorporation may alter formulation behaviour. Increasing extract concentration can influence viscosity, colour, odour, pH, and potentially foaming. This makes concentration optimization particularly important. A high concentration of plant extract is not necessarily equivalent to a superior cosmetic formulation.

The surfactant system is similarly central to product performance. Surfactants must provide sufficient interaction with sebum and other surface contaminants while minimizing unnecessary disruption of the skin barrier. The most suitable formulation is therefore unlikely to be the one containing the highest surfactant concentration. Instead, optimization should identify the lowest or most appropriate surfactant level capable of producing satisfactory cleansing under the defined test conditions.

The relationship between foam and cleansing requires particular attention. Consumers frequently associate foam with cleansing effectiveness, but foam volume is a physical phenomenon influenced by surfactant concentration, formulation viscosity, air incorporation, and other variables. Therefore, a scientifically defensible formulation study should measure cleansing efficiency independently from foam characteristics.

pH is another critical variable because the facial cleanser interacts directly with the skin. An appropriately selected pH can contribute to skin compatibility while also affecting the behaviour of preservatives, surfactants, polymers, and botanical constituents. Thus, pH should be optimized as part of the complete formulation rather than selected without consideration of other components.

Viscosity provides a further example of the need for balance. The product should be sufficiently viscous to permit controlled dispensing and comfortable application, but not so viscous that spreading and rinsing become difficult. Changes in viscosity may also indicate physical instability during subsequent storage studies.

The use of a paraben-free preservation approach requires equally careful interpretation. The absence of parabens does not by itself establish microbiological safety. A water-containing cleanser must have an effective preservation strategy supported by appropriate microbiological testing. Botanical extracts may themselves possess antimicrobial constituents, but their presence should not be assumed to provide adequate preservation of the finished product. The final preservation system should be evaluated in the actual formulation matrix.

5.2 Scientific Significance

The study contributes to the growing body of cosmetic formulation research by demonstrating a structured methodology for developing botanical facial cleansers. It emphasizes that “herbal” and “paraben-free” are formulation characteristics rather than independent indicators of efficacy or safety.

The work also highlights the importance of connecting phytochemical considerations with pharmaceutical and cosmetic formulation principles. Botanical extracts should be characterized, standardized where feasible, and assessed for compatibility with the surfactant and excipient system.

5.3 Practical Significance

A successfully optimized formulation may provide a basis for development of herbal facial cleansing products that combine:

- botanical functionality;
- effective cleansing;
- suitable rheology;
- acceptable sensory characteristics;
- appropriate skin-oriented pH;
- controlled preservation; and
- acceptable physical stability.

The formulation approach can also be adapted to different combinations of botanical ingredients and surfactant systems.

5.5 Conclusion

The formulation of a herbal paraben-free face wash requires systematic integration of botanical selection, extraction, surfactant science, rheological control, cleansing performance, pH management, preservation, and quality evaluation. The central formulation objective is not merely to produce a product containing herbal extracts or excluding parabens, but to establish a balanced formulation capable of providing acceptable cleansing while maintaining appropriate physicochemical characteristics.

The proposed experimental design provides a rational pathway for comparing formulation batches and identifying the best-performing composition. Botanical extracts should be selected according to scientifically relevant characteristics and incorporated at concentrations supported by compatibility and optimization studies. Surfactant concentration should be controlled to balance cleansing and mildness, while viscosity should be adjusted to provide practical application and dispensing characteristics.

Most importantly, optimization should be based on integrated performance. The final formulation should demonstrate satisfactory pH, viscosity, spreadability, foaming, cleansing, washability, homogeneity, and stability rather than excelling in only one parameter.

REFERENCES

1. Ananthapadmanabhan, K.P., Moore, D.J., Subramanyan, K., Misra, M. and Meyer, F. (2004). Cleansing without compromise: The impact of cleansers on the skin barrier and the technology of mild cleansing. *Dermatologic Therapy*, 17(Suppl. 1), 16–25.
2. Bakkali, F., Averbeck, S., Averbeck, D. and Idaomar, M. (2008). Biological effects of essential oils—A review. *Food and Chemical Toxicology*, 46(2), 446–475.
3. Biswas, K., Chattopadhyay, I., Banerjee, R.K. and Bandyopadhyay, U. (2002). Biological activities and medicinal properties of neem (*Azadirachta indica*). *Current Science*, 82(11), 1336–1345.
4. Brand-Williams, W., Cuvelier, M.E. and Berset, C. (1995). Use of a free radical method to evaluate antioxidant activity. *LWT—Food Science and Technology*, 28(1), 25–30.
5. Burt, S. (2004). Essential oils: Their antibacterial properties and potential applications in foods—A review. *International Journal of Food Microbiology*, 94(3), 223–253.
6. Carson, C.F., Hammer, K.A. and Riley, T.V. (2006). Melaleuca alternifolia (tea tree) oil: A review of antimicrobial and other medicinal properties. *Clinical Microbiology Reviews*, 19(1), 50–62.
7. Cohen, M.M. (2014). Tulsi—*Ocimum sanctum*: A herb for all reasons. *Journal of Ayurveda and Integrative Medicine*, 5(4), 251–259.
8. Darbre, P.D. and Harvey, P.W. (2008). Paraben esters: Review of recent studies of endocrine toxicity, absorption, esterase and human exposure, and discussion of potential human health risks. *Journal of Applied Toxicology*, 28(5), 561–578.
9. Dorman, H.J.D. and Deans, S.G. (2000). Antimicrobial agents from plants: Antibacterial activity of plant volatile oils. *Journal of Applied Microbiology*, 88(2), 308–316.
10. Elias, P.M. (2005). Stratum corneum defensive functions: An integrated view. *Journal of Investigative Dermatology*, 125(2), 183–200.
11. Golden, R., Gandy, J. and Vollmer, G. (2005). A review of the endocrine activity of parabens and implications for potential risks to human health. *Critical Reviews in Toxicology*, 35(5), 435–458.
12. Hammer, K.A., Carson, C.F. and Riley, T.V. (1999). Antimicrobial activity of essential oils and other plant extracts. *Journal of Applied Microbiology*, 86(6), 985–990.
13. Hewlings, S.J. and Kalman, D.S. (2017). Curcumin: A review of its effects on human health. *Foods*, 6(10), 92.
14. Holmberg, K., Jönsson, B., Kronberg, B. and Lindman, B. (2003). *Surfactants and Polymers in Aqueous Solution*. 2nd ed. Chichester: Wiley.
15. Israelachvili, J.N. (2011). *Intermolecular and Surface Forces*. 3rd ed. London: Academic Press.

16. Jamshidi, N. and Cohen, M.M. (2017). The clinical efficacy and safety of Tulsi in humans: A systematic review of the literature. *Evidence-Based Complementary and Alternative Medicine*, 2017, 9217567.
17. Kalemba, D. and Kunicka, A. (2003). Antibacterial and antifungal properties of essential oils. *Current Medicinal Chemistry*, 10(10), 813–829.
18. Lambers, H., Piessens, S., Bloem, A., Pronk, H. and Finkel, P. (2006). Natural skin surface pH is on average below 5, which is beneficial for its resident flora. *International Journal of Cosmetic Science*, 28(5), 359–370.
19. Molyneux, P. (2004). The use of the stable free radical diphenylpicrylhydrazyl (DPPH) for estimating antioxidant activity. *Songklanakarin Journal of Science and Technology*, 26(2), 211–219.
20. Nazzaro, F., Fratianni, F., De Martino, L., Coppola, R. and De Feo, V. (2013). Effect of essential oils on pathogenic bacteria. *Pharmaceuticals*, 6(12), 1451–1474.
21. Pattanayak, P., Behera, P., Das, D. and Panda, S.K. (2010). *Ocimum sanctum* Linn. A reservoir plant for therapeutic applications: An overview. *Pharmacognosy Reviews*, 4(7), 95–105.
22. Proksch, E., Brandner, J.M. and Jensen, J.M. (2008). The skin: An indispensable barrier. *Experimental Dermatology*, 17(12), 1063–1072.
23. Re, R., Pellegrini, N., Proteggente, A., Pannala, A., Yang, M. and Rice-Evans, C. (1999). Antioxidant activity applying an improved ABTS radical cation decolorization assay. *Free Radical Biology and Medicine*, 26(9–10), 1231–1237.
24. Rhein, L.D. and Schlossman, M.L. (eds.) (2017). *Surfactants in Personal Care Products and Decorative Cosmetics*. 3rd ed. Boca Raton: CRC Press.
25. Rosen, M.J. and Kunjappu, J.T. (2012). *Surfactants and Interfacial Phenomena*. 4th ed. Hoboken: Wiley.
26. Schmid-Wendtner, M.H. and Korting, H.C. (2006). The pH of the skin surface and its impact on the barrier function. *Skin Pharmacology and Physiology*, 19(6), 296–302.
27. Schnuch, A., Uter, W., Geier, J., Gefeller, O. and IVDK Study Group (2007). Contact allergy to essential oils and botanical extracts. *Contact Dermatitis*, 57, 1–8.
28. Subapriya, R. and Nagini, S. (2005). Medicinal properties of neem leaves: A review. *Current Medicinal Chemistry—Anti-Cancer Agents*, 5(2), 149–156.
29. Surjushe, A., Vasani, R. and Saple, D.G. (2008). Aloe vera: A short review. *Indian Journal of Dermatology*, 53(4), 163–166.
30. Vaughn, A.R., Branum, A. and Sivamani, R.K. (2016). Effects of turmeric (*Curcuma longa*) on skin health: A systematic review of the clinical evidence. *Phytotherapy Research*, 30(8), 1243–1264.