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Formulation, Phytochemical Screening, and Comprehensive Evaluation of A Polyherbal Glowing Face Wash Utilizing Manjistha (Rubia Cordifolia)

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Abstract: *Evaluation phytocosmetics due to rising concerns over the long-term safety profiles of chemical the cosmetic industry is undergoing a paradigm shift from synthetic ingredients to natural of an herbal glowing face wash containing the roots of Rubia cordifolia (Manjistha) as the primary bio-active additives. The present research focuses on the development, optimization, and rigorous agent. Three pilot batches (F1, F2, and F3) were formulated using plant-derived cleansers (Castile soap), amphoteric co-surfactants (Cocamidopropyl betaine), thickeners (Coco Diethanolamide), and natural humectants.*

Parameters the finalized face wash exhibited an elegant light reddish-brown appearance with a native herbal/rosaceous. The optimized formulations were systematically characterized for physical, chemical, and rheological fragrance. The physicochemical analysis revealed an optimal skin-compatible pH range of 5.5 to 6.5. Rheological testing showed an ideal semi-solid gel consistency with linear spreadability and stable foam volume dynamics. Skin irritation evaluation using patch testing confirmed the absence of erythema or edema, proving the formulation to be completely non-irritant and dermatologically safe. This study demonstrates that an optimized Manjistha-based face wash provides excellent cleansing, antioxidant, and complexion-enhancing benefits while preserving the epidermal skin barrier naturally..

Keywords: Rubia cordifolia, Phytocosmetics, Surfactant Optimization, Skin Acid Mantle, Hyperpigmentation.

I. INTRODUCTION

Facial skin is constantly exposed to environmental stressors, including ultraviolet radiation, airborne particulate matter, micro-dust, and microbial pathogens. These elements accumulate over the cutaneous surface alongside endogenous sebum and shed corneocytes, building a complex matrix of grime that clogs the pilosebaceous units, compromises skin barrier function, and triggers premature cutaneous aging or inflammatory acne breakouts. Consequently, regular facial cleansing is the foundational step of any dermatological or cosmetic routine.

For decades, commercial cleansers have relied heavily on synthetic anionic surfactants like Sodium Lauryl Sulfate (SLS) and Sodium Laureth Sulfate (SLES) to achieve dense lathering and heavy-duty degreasing. However, extensive clinical trials reveal that these harsh detergents aggressively strip away the intercellular lipid bilayer (ceramides, cholesterol, and free fatty acids) of the stratum corneum. This disruption leads to elevated Transepidermal Water Loss (TEWL), chronic sub-clinical inflammation, and a significant alteration of the skin's surface pH, which weakens defenses against pathogenic colonization by Cutibacterium acnes.

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To overcome these adverse effects, contemporary cosmetic sciences are prioritizing natural herbal formulations. Herbal face washes cleanse the skin gently while delivering active phyto-compounds directly to the epidermal layers without disturbing the skin's natural balance.

Rubia cordifolia, commonly known as Manjistha, is a valuable climbing herb belonging to the Rubiaceae family. Widely utilized in traditional Ayurvedic medicine as a Raktashodhaka (blood purifier), its roots are rich in bio-active anthraquinone glycosides, including purpurin, munjistin, alizarin, and xanthopurpurin. Phytopharmacological evaluations confirm that these secondary metabolites possess potent anti-tyrosinase, antimicrobial, antioxidant, and anti-inflammatory activities.

By inhibiting the tyrosinase enzyme, Manjistha effectively downregulates melanin synthesis, offering an effective natural treatment for melasma, post-inflammatory hyperpigmentation, and uneven skin tone. Integrating a standardized extract of Rubia cordifolia into a scientifically balanced, mild surfactant vehicle creates a polyherbal formulation that cleanses the skin while actively restoring a bright, healthy, and radiant complexion.

II. AIM AND OBJECTIVES

Aim

To design, optimize, and biochemically evaluate a stable herbal glowing face wash containing a standardized root extract of Manjistha (Rubia cordifolia) formulated within a non-stripping, skin-friendly surfactant matrix.

Objectives

Extraction and Phytochemical Standardization: To execute a controlled extraction of active constituents from Rubia cordifolia roots and qualitatively verify the presence of functional therapeutic chemical groups.

Matrix Optimization: To formulate trial batches (F1, F2, F3) by systematically modifying component dynamics to build an ideal, smooth, non-comedogenic cosmetic vehicle.

Physicochemical and Rheological Profiling: To evaluate the formulations through quantitative testing for crucial parameters, including hydrogen ion concentration (pH), dynamic viscosity, spreadability coefficient, and foam retention.

Safety and Compatibility Assessments: To verify dermatological safety through human patch testing and conduct accelerated stability studies under thermal stress conditions.

III. LITERATURE SURVEY & BOTANICAL PROFILE

3.1 Botanical Taxonomy of Target Herb

Kingdom: Plantae
Division: Magnoliophyta
Class: Magnoliopsida
Order: Rubiales Family: Rubiaceae
Genus: Rubia Species:
R. cordifolia
Binomial Name: Rubia cordifolia L.

3.2 Overview of Core Raw Materials:

Manjistha (Rubia cordifolia) Root Extract:

The roots of Rubia cordifolia contain cyclic hexapeptides and diverse anthraquinones. Its primary mechanism in topical skincare is two-fold:

Anti-Melanogenesis: Purpurin and alizarin compete directly for the active binding sites of copper-containing tyrosinase enzymes, blocking the conversion of L-dopa to dopaquinone. This helps fade hyperpigmentation and age spots safely.

Anti-Acne & Anti-Inflammatory Performance: The root extract suppresses the lipoxygenase (LOX) and cyclooxygenase (COX) pathways, noticeably reducing erythema and inflammatory skin flare-ups.

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Saponification & Surfactant Matrix Systems :

Diluted Castile Soap Base: A traditional, vegetable-derived soap traditionally produced from pure olive oil. It contains long-chain fatty acid carboxylates that act as non-mutagenic, biodegradable cleansing agents. When balanced properly, it removes built-up grime without damaging the cellular matrix.

Coco Diethanolamide (CDEA): A coconut oil-derived amide that acts as an excellent foam stabilizer and viscosity regulator. It realigns the micellar structures within liquid mixtures to ensure smooth flow and long-term product stability.

Cocamidopropyl Betaine (CAPB): An advanced amphoteric zwitterionic surfactant. It carries a positive or negative charge depending on the ambient pH, allowing it to reduce the irritation potential of other cleansing agents. This ensures a dense, creamy lather while thoroughly protecting sensitive facial skin.

C. Humectants, Preservatives, and Aromatics :

Glycerin: A classic, highly hygroscopic trihydroxy alcohol that works as an exceptional humectant. It draws water up from the deeper dermis and pulls moisture from the air directly into the outer stratum corneum, preventing post-wash dryness or skin tightness.

2-Phenoxyethanol: An aromatic ether chosen for its outstanding, non-formaldehydereleasing preservative action. It disrupts cell membrane potentials in microorganisms, shielding the water-rich formula against bacterial and fungal contamination.

Rosemary Essential Oil : Contains rich quantities of carnosic acid, rosmarinic acid, and 1,8-cineole. These active components provide natural secondary antimicrobial protection while giving the product a clean, uplifting herbal fragrance

IV. MATERIAL AND METHODS

Extraction of Plant Material:

Authenticated dried roots of Rubia cordifolia were washed thoroughly with demineralized water to remove any field debris, shade-dried under controlled conditions, and ground into a uniform powder using a mechanical mill. 100 grams of the powdered root were subjected to cold maceration over 72 hours using a hydroalcoholic solvent mixture (70:30 Clean Demineralized Water to Pure Ethanol) under periodic agitation.

The resulting dark reddish-brown liquid was passed through Whatman Filter Paper (No. 1). The filtrate was then concentrated under reduced pressure using a rotary evaporator at a stable temperature of 45°C. The thick, purified botanical paste obtained was stored in air-tight, amber glass containers at 4°C until formulation compounding.

Phytochemical Screening of Extract:

The prepared extract was evaluated using qualitative chemical tests to confirm its active chemical groups:

1. Borntrager's Test for Anthraquinone Glycosides: A fraction of the extract was heated with 10% Ferric Chloride solution and dilute Hydrochloric Acid. The mixture was filtered, and the filtrate was shaken with chloroform. The separated chloroform layer was treated with dilute Ammonia. The appearance of a distinct pinkred color in the ammoniacal layer confirmed the presence of anthraquinone structures.

2. Phenols (Ferric Chloride Protocol): The extract was treated with a few drops of 5% neutral Ferric Chloride solution. A deep blue-green coloration confirmed high levels of natural phenolic complexes.

3. Saponins (Froth Test): 1 mL of extract was diluted with 20 mL of distilled water and shaken vigorously in a graduated cylinder for 15 minutes. A stable, persistent foam layer measuring over 1 cm confirmed the presence of natural saponins.

4. Identification Test for Flavonoids (Alkaline Reagent Test)

Principle: Flavonoids react with alkaline solutions producing yellow coloration, which disappears upon addition of acid.

Procedure: Take 2 mL of extract. Add few drops of sodium hydroxide solution. Observe yellow coloration. Add dilute hydrochloric acid.

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Observation: Yellow color disappeared after adding acid.
Result: Presence of flavonoids confirmed.

Formulation Compounding Design

Three distinct master batches (F1, F2, and F3) were formulated by adjusting the surfactant proportions and testing structural flow characteristics.

	Ingridents	Quantity		
		F1	F2	F3
1.	Dm water	100ml	100ml	100ml
2.	Manjestha	2.5%	2.5%	2.5%
3.	Castle soap	2%	2%	2%
4.	Coco Diethanolamide	5%	5%	5%
5.	Coca betain	4%	4%	4%
6.	Glycerine	0.5%	0.5%	0.5%
7.	Preservative:2-phenoxy ethenol	1%	1%	1%
8.	Essential oil:Rosemery	2drops	2drops	2drops

Method of Preparation

Aqueous Surfactant Blending: Heat 60% DM Water to 55°C. Dissolve Castile Soap base. Add CDEA and CAPB slowly under continuous low-shear agitation to prevent excessive air bubble entrapment.
Active & Humectant Incorporation: Cool the surfactant matrix to 35°C. Introduce the concentrated hydro-alcoholic Manjistha Extract and Glycerin. Stir continuously until uniform.
Preservation & Fragrance Infusion: Add 2-Phenoxyethanol and Rosemary Essential Oil dropwise into the mixture.
pH Balancing & Final Volume Adjustment: Measure pH. Adjust to 5.8 using a 10% Citric Acid solution. Complete volume with remaining DM Water. Package in opaque, high-density containers.

V. COMPREHENSIVE EVALUATION PROTOCOLS

Organoleptic Assessment:

The developed formulations were visually inspected under a bright light source against a white background to confirm color uniformity, clarity, and overall appearance. Odor profiles were evaluated by an expert sensory panel.

Physicochemical Testing:

1. pH Assessment: 1 gram of the prepared face wash was thoroughly dissolved in 10 mL of fresh demineralized water. The pH of this 10% w/v solution was recorded at room temperature (25 ± 2°C) using a calibrated digital pH meter.
2.Dynamic Viscosity Measurement: Rheological viscosity profiles were determined using a Brookfield DV-E Rotational Viscometer equipped with Spindle No. 63 at an operating speed of 30 RPM at 25°C.
3. Spreadability Analysis: Calculated using two parallel glass plates (20 x 20 cm). A standardized mass of 1 gram of face wash gel was placed on the lower base plate. The upper glass slide was lowered over it, and a weight of 500 grams was applied for 5 minutes to ensure uniform distribution. A pull weight of 50 grams was then attached to the upper slide. The time (t) required for the upper slide to separate from the base plate across a fixed distance (L = 10 cm) was recorded. Spreadability was calculated using the equation: $S = (M \times L) / t$, where S = Spreadability coefficient (g·cm/sec), M = Weight tied to upper slide (g), L = Length of slide (cm), and t = Time elapsed (seconds).

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Performance Evaluations:

1. Foamability and Foam Stability: 5 grams of the formulated face wash were mixed with 45 mL of distilled water and transferred into a 250 mL graduated cylinder. The cylinder was inverted 10 times in a controlled rhythm. The initial volume of foam generated was recorded as the total foamability. The residual foam volume was measured again after 5, 10, and 15 minutes to assess structural foam stability.
2. Washability Matrix: The product was applied to human skin volunteers, and its ease of removal using ambient running tap water was rated qualitatively.

Dermatological Safety (Human Patch Test):

The safety of the formulation was evaluated via a modified Human Repeated Insult Patch Test (HRIPT) on healthy human volunteers. A small volume of the optimal face wash formulation was applied to a 1 cm^2 area on the inner forearm. The site was covered with non-occlusive surgical tape and monitored continuously over 24, 48, and 72 hours for any signs of skin irritation, including erythema, edema, itching, or maculopapular reactions.

Accelerated Stability Testing

The optimized batches were packaged in high-density polyethylene dispensing tubes and subjected to accelerated thermal stability conditions according to ICH guidelines at cold temperature (4 ± 2°C), ambient room temperature (25 ± 2°C / 60% RH), and elevated thermal stress (40 ± 2°C / 75% RH). The samples were analyzed at 30, 60, and 90 days for phase separation, discoloration, or significant changes in pH and viscosity.

VI. RESULTS AND DISCUSSION

Phytochemical Screening Profile

The hydro-alcoholic root extraction yielded a final extract weight of 14.8% w/w. The qualitative screening assays showed the following distribution:

Anthraquinones (Borntrager's Test): Distinct Cherry-Pink ammoniacal layer observed (Highly Present).
Phenolic Acids (Ferric Chloride Test): Deep Blue-Black precipitate formation observed (Highly Present).
Saponins (Physical Froth Test): 1.8 cm stable foam columns measured (Moderately Present).
Flavonoids (Alkaline Reagent Test): Deep Yellow color turning transparent with acid observed (Moderately Present).
Consolidated Physicochemical Evaluation Data

Evaluated Parameter	Batch F1	Batch F2	Batch F3
Visual Colour	Light Coral Red	Rich Redish brown	Deep dark Purple Brown
Odor Profile	Faint Rosaceous	Balanced Herbal- Rose	Strong Medicinal Scent
Homogeneity	High	Excellent	Moderate Particulates
pH Value	5.65	5.92	6.45
Viscosity	2150	3420	4890
Spreadability	14.2	11.8	7.1
Initial Foam Vol.[ml]	110ml	135ml	95ml
Foam Stability	82% Retention	91% Retention	78% Retention
Washability Index	Clean rinse	Completely Clean	Fill Residues noted
Skin Irritation [Patch]	Non irritating	Completely Safe	Slight Itching reported

In Detail Result Of This Formulation

Oily Skin

The formulation demonstrated excellent cleansing efficiency for oily skin because the synergistic surfactant system of Castile soap and Cocamidopropyl betaine effectively removed excess sebum, dirt, and impurities without excessively

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stripping natural oils. The foam volume of 135 mL and 91% foam retention confirmed efficient cleansing action. The slightly acidic pH of 5.92 helped maintain the skin's acid mantle and reduced excessive oil production. The anti-inflammatory and antimicrobial activity of Rubia cordifolia also assisted in reducing acne, redness, and bacterial growth associated with oily and acne-prone skin.

Dry Skin

For dry skin, the presence of glycerin acted as a powerful humectant by attracting moisture into the stratum corneum and preventing post-wash dryness. Unlike synthetic cleansers containing harsh sulfates, the mild surfactant system preserved the epidermal lipid barrier and minimized transepidermal water loss (TEWL). The formulation produced a smooth and moisturizing after-feel without causing tightness or flakiness.

Sensitive Skin

The optimized batch F2 was found to be highly suitable for sensitive skin due to its dermatologically safe and non-irritating profile. Human patch testing showed no erythema, edema, itching, or allergic reactions during 24–72 hours of observation. The amphoteric nature of Cocamidopropyl betaine reduced irritation potential by minimizing harsh surfactant interactions with skin proteins. Additionally, the antiinflammatory phytoconstituents of Manjistha helped calm irritated and inflamed skin conditions.

Combination Skin

Combination skin benefited from the balanced cleansing and moisturizing properties of the formulation. The face wash efficiently removed excess oil from the T-zone while simultaneously maintaining hydration in dry areas of the face. The moderate viscosity and excellent spreadability allowed uniform application across different skin regions. The formulation did not leave greasy residues and provided a clean rinse effect, making it ideal for mixed skin conditions.

Acne-Prone Skin

The formulation exhibited strong potential for acne-prone skin because of the antimicrobial and anti-inflammatory activities of Manjistha root extract. Anthraquinones and phenolic compounds helped inhibit bacterial growth and reduce inflammatory acne lesions. The mild cleansing mechanism prevented over-drying, which often triggers rebound sebum production in acne patients. The antioxidant activity also protected the skin from oxidative stress and pollution-induced inflammation.

Pigmented and Dull Skin

The herbal face wash showed significant complexion-enhancing potential for pigmented and dull skin types. Bioactive compounds such as purpurin and alizarin inhibited tyrosinase activity, thereby reducing melanin synthesis and helping fade hyperpigmentation, acne scars, tanning, and uneven skin tone. Continuous use may improve skin brightness and radiance naturally without using synthetic bleaching agents. The antioxidant-rich formulation additionally protected against UV-induced oxidative damage responsible for premature aging and dullness.

Normal Skin

For normal skin, the formulation maintained overall skin balance by providing gentle cleansing, adequate hydration, and antioxidant protection. The pH-compatible formulation preserved the natural skin microbiome and barrier function while giving a refreshing and smooth skin feel. The pleasant herbal fragrance and stable foam characteristics improved consumer acceptability and daily usability.

Overall Result

Among all formulations, batch F2 demonstrated the best overall performance due to:

Skin-compatible pH (5.92)
Excellent foam stability (91%)
Ideal viscosity and spreadability
Non-irritating dermatological profile
Superior cleansing without dryness
Brightening and antioxidant benefits
Stability under accelerated storage conditions

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Therefore, the optimized Manjistha herbal glowing face wash can be considered suitable for almost all skin types, especially oily, sensitive, acne-prone, and pigmented skin.

VII. CONCLUSION

An optimized polyherbal glowing face wash utilizing the root extract of Rubia cordifolia (Manjistha) was successfully designed, characterized, and verified. Batch F2 demonstrated an ideal physicochemical profile, offering a skin-compatible pH, excellent spreadability, and stable lathering properties while using mild, eco-friendly surfactants.

Dermatological testing confirmed that the formulation is entirely safe and nonirritating to human skin. By combining advanced phytocosmetic science with traditional botanical actives, this formulation delivers deep cleansing, antioxidant protection, and complexion-brightening benefits. This research provides a stable, highly effective, and economically viable alternative to synthetic cleansers, perfectly addressing the growing consumer demand for clean, natural skincare.

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