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FORMULATION AND EVALUATION OF HERBAL BODY SCRUB USING NATURAL INGREDIENTS

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Abstract: Body scrub is a semi-solid cosmetic product that is widely employed to cleanse, exfoliate, and revitalize the skin. Exfoliation is crucial for maintaining healthy skin, as it helps remove accumulated dead cells from the stratum corneum, thereby improving texture, tone, and general appearance. In recent years, growing consumer concerns about the adverse effects of synthetic chemicals present in commercial formulations have driven a significant increase in demand for natural and herbal cosmetics. In the present study, natural ingredients including sugar, aloe vera gel, coconut oil, body wash, freeze-dried strawberry powder, rose essential oil, vitamin E, and distilled water were selected for the formulation and evaluation of a herbal body scrub. Each component was chosen based on its functional properties: sugar serves as a natural exfoliant with humectant activity; aloe vera gel provides soothing, calming, and moisturizing benefits; coconut oil acts as an emollient with antibacterial properties; body wash constitutes the mild cleansing base; freeze-dried strawberry powder contributes antioxidant properties and gentle exfoliation; rose essential oil enhances aroma and provides antimicrobial effects; and vitamin E functions as a natural antioxidant preservative. Four batches (B1–B4) were prepared, with Batch 4 representing the optimized standard formulation. The prepared scrub was systematically evaluated for physicochemical parameters including pH, spreadability, texture, homogeneity, washability, viscosity, stability, irritation, particle size, and extrudability. Test results demonstrated that Batch 4 (standard) exhibited optimal characteristics across all evaluation criteria, including a skin-compatible pH of 5.5, smooth uniform texture, excellent spreadability, and full stability under all tested storage conditions. The study thereby confirms that the herbal body scrub is a safe, efficacious, and cost-effective alternative to synthetic cosmetic formulations.

Index Terms — Herbal Body Scrub, Natural Exfoliation, Aloe Vera, Coconut Oil, Strawberry Powder, Physicochemical Evaluation, Cosmetic Formulation, Green Pharmacy

I. INTRODUCTION

The skin is the largest organ of the human body, serving as a primary protective barrier against environmental pollutants, ultraviolet radiation, and pathogenic microorganisms. In addition to its protective role, the skin performs vital sensory and thermoregulatory functions. The outermost layer of the epidermis, the stratum corneum, undergoes continuous desquamation and renewal. Accumulation of dead cells over time can result in dull, rough, and uneven skin texture, necessitating regular mechanical or chemical exfoliation to maintain healthy, radiant skin [1].

Exfoliation refers to the physical or chemical removal of dead skin cells from the skin surface. Among the available methods, mechanical exfoliation using scrub formulations has gained widespread popularity due to its ease of use, effectiveness, and rapid visible results. Body scrubs are semi-solid cosmetic preparations containing abrasive particles that physically remove dead skin cells while simultaneously improving blood circulation, stimulating cell regeneration, and enhancing the absorption of subsequent topical products [2].

The cosmetic industry has witnessed a remarkable shift in consumer preference toward herbal and natural formulations over the past decade. Synthetic products frequently contain excipients such as parabens, sulfates, and synthetic fragrances, which have been associated with allergic reactions, skin irritation, endocrine disruption, and other long-term adverse effects. In contrast, herbal cosmetics employ plant-derived and mineral-based ingredients that offer greater skin biocompatibility, therapeutic benefits, and a reduced risk of adverse reactions [3].

A well-formulated body scrub typically comprises three essential components: (i) an exfoliating agent to remove dead skin cells, (ii) a moisturizing agent to maintain skin hydration, and (iii) a cleansing base to facilitate removal of impurities. The selection of appropriate ingredients is critical to ensure the final product's stability, efficacy, and consumer acceptability [4].

Sugar is among the most commonly utilized natural exfoliating agents due to its mildly abrasive particle structure combined with humectant properties that promote moisture retention in the skin. Aloe vera gel is widely valued in cosmetic science for its exceptional soothing, hydrating, and anti-inflammatory activities, making it particularly suited for sensitive and irritated skin. Coconut oil, enriched in medium-chain fatty acids including lauric acid, serves as an effective emollient that preserves the integrity of the skin's lipid barrier and prevents transepidermal water loss [5].

Fruit-based bioactive agents, particularly freeze-dried strawberry powder, provide significant functional value in cosmetic formulations. Strawberries are naturally rich in vitamin C, phenolic antioxidants, and alpha-hydroxy acids (AHAs) that collectively help reduce oxidative skin damage, improve skin luminosity, and facilitate dual-mode exfoliation — both physical and mild chemical. Rose essential oil contributes a pleasant characteristic fragrance alongside documented antimicrobial, anti-inflammatory, and skin-calming properties [6].

The development of herbal cosmetic formulations is also aligned with the global movement toward sustainability and eco-conscious consumerism. Natural ingredients are generally biodegradable, less toxic, and safer for prolonged topical use compared to their synthetic counterparts. Furthermore, many such formulations can be prepared using simple equipment and straightforward processing techniques, making them viable for small-scale production and accessible in resource-limited settings [7].

Accordingly, the present study was undertaken to formulate and evaluate a herbal body scrub utilizing carefully selected natural ingredients. The study comprehensively assesses the physicochemical properties, stability, safety, and therapeutic performance of four batches prepared with systematic compositional variations, with the objective of identifying the optimal formulation suitable for regular topical application [8, 9].

II. AIM AND OBJECTIVES

2.1 Aim

The primary aim of the present study is to formulate and evaluate a herbal body scrub using natural ingredients — including sugar, aloe vera gel, coconut oil, body wash, freeze-dried strawberry powder, rose essential oil, and vitamin E — with the objective of developing a safe, effective, and economical cosmetic formulation that provides exfoliation, moisturization, and nourishment to the skin while minimizing reliance on synthetic chemicals.

2.2 Objectives

1. To select suitable natural ingredients with well-established exfoliating, moisturizing, antioxidant, and cleansing properties for body scrub formulation.
2. To formulate four batches of herbal body scrub, including a standard optimized batch (Batch 4) and three batches with systematic compositional deviations (Batches 1–3).
3. To study the functional role and pharmacognostic properties of each ingredient used in the formulation.
4. To evaluate all batches for physicochemical parameters including pH, texture, spreadability, homogeneity, washability, viscosity, particle size, and extrudability.
5. To assess the stability of the formulations under varying storage conditions (ambient, refrigerated, and accelerated temperatures).
6. To perform patch/irritation tests to confirm dermatological safety and skin compatibility.
7. To compare batch results and identify the most optimal formulation with reference to all evaluation parameters.
8. To contribute to the development of cost-effective, eco-friendly herbal cosmetic alternatives to synthetic body scrubs.

III. LITERATURE REVIEW

Cosmetic preparations employing plant-derived and mineral ingredients for skin care have been practiced since antiquity, with documented use across diverse cultural traditions. In contemporary cosmetology, body scrubs are recognized as important exfoliating preparations that promote skin cell turnover, improve blood microcirculation, and facilitate the removal of accumulated keratinized cells. Mechanical exfoliation using natural abrasives has demonstrated superior tolerability over chemical peeling agents, particularly for regular home-use regimens [10].

The global cosmeceutical market has witnessed a paradigm shift toward herbal formulations, driven largely by consumer awareness of potential risks associated with synthetic ingredients. Parabens — widely used synthetic preservatives — have been detected in human breast tissue and linked to endocrine disruption at high concentrations, prompting regulatory scrutiny and consumer avoidance [11]. Similarly, sodium lauryl sulfate (SLS), a common surfactant in synthetic scrubs, is known to disrupt the skin's natural barrier when used in high concentrations, leading to dryness and inflammation.

Sugar-based scrubs have been the focus of considerable research interest owing to their dual functionality as both a mechanical exfoliant and a natural humectant. Unlike salt-based scrubs, which can cause stinging and micro-abrasion in individuals with compromised skin barriers, sugar granules dissolve rapidly in water, offering a gentler exfoliation profile suitable for diverse skin types [12]. A study by Lodén (2003) demonstrated that regular use of humectant-containing scrubs significantly improved skin hydration indices and reduced transepidermal water loss (TEWL) [12].

Aloe vera (Aloe barbadensis Miller) is among the most extensively researched medicinal plants in dermatological applications. Its gel contains mucopolysaccharides, glycoproteins, anthraquinones, saponins, and minerals — collectively responsible for its well-documented moisturizing, wound-healing, anti-inflammatory, and antimicrobial effects. Surjushe et al. (2008) reported that aloe vera gel application reduced erythema and improved skin barrier function in subjects with mild dermatitis [5].

The emollient and antimicrobial properties of virgin coconut oil (VCO) have been validated by several clinical studies. Verallo-Rowell et al. (2008) demonstrated that VCO is as effective as mineral oil in reducing TEWL in patients with atopic dermatitis, while additionally exhibiting significant antibacterial activity against Staphylococcus aureus — a common pathogen in skin infections [13]. The high lauric acid content of coconut oil forms a lipid film that supports the skin's natural barrier, making it ideal for inclusion in moisturizing cosmetic preparations.

Phytochemical analysis of strawberry (Fragaria × ananassa) reveals significant concentrations of ellagic acid, pelargonidin, quercetin, ascorbic acid (vitamin C), and folic acid. These compounds collectively exert antioxidant, anti-pigmentation, and anti-inflammatory activities on the skin. Giampieri et al. (2012) reported that topical application of strawberry-derived extracts reduced oxidative stress markers in human skin fibroblasts and improved skin luminosity scores in clinical assessment [6].

Essential oils, particularly rose oil (Rosa damascena), have been incorporated in dermatological and cosmetic preparations for centuries. Burt (2004) reviewed the antibacterial mechanisms of essential oils, attributing their activity to disruption of the microbial cell membrane by terpene constituents [14]. At concentrations below 2% in cosmetic formulations, rose oil is generally non-sensitizing and provides significant olfactory and psychological benefits, including stress reduction and mood elevation.

Quality evaluation of semi-solid cosmetic formulations encompasses a comprehensive panel of physicochemical tests. ICH Q1A(R2) guidelines mandate stability testing under specified temperature and humidity conditions to validate shelf life and storage recommendations for cosmetic and pharmaceutical products [20]. Parameters including pH, viscosity, spreadability, and homogeneity are recognized by standard references (British Pharmacopoeia, USP, and Indian Pharmacopoeia) as critical quality attributes (CQAs) for semi-solid preparations.

Collectively, the reviewed literature strongly supports the use of the selected ingredients — sugar, aloe vera gel, coconut oil, strawberry powder, and rose oil — in an herbal body scrub formulation. The present study builds upon this evidence base by conducting a systematic multi-batch comparative evaluation to establish an optimal formulation with validated quality, safety, and efficacy profiles [11, 15].

IV. MATERIALS AND INGREDIENTS

The herbal body scrub was formulated using carefully selected natural ingredients, each evaluated for pharmaceutical-grade purity, skin compatibility, stability, and functional performance. All raw materials used in the study were procured from certified suppliers and tested for identity, purity, and microbial load prior to

use. The formulation was developed with a focus on combining exfoliating, moisturizing, cleansing, and therapeutic properties in a single, stable semi-solid product [11].

4.1 Ingredient Summary Table

Table 1: Ingredient Summary of Herbal Body Scrub Formulation

Ingredient	Role / Function	Quantity	Physical Form
Sugar (Sucrose)	Natural exfoliant & humectant	40 g	Fine white crystals
Aloe Vera Gel	Soothing & moisturizing agent	20 g	Clear, viscous gel
Coconut Oil	Emollient & antibacterial	15 g	White semi-solid
Body Wash	Mild cleansing base	15 g	Liquid surfactant
Strawberry Powder	Antioxidant & mild exfoliant	5 g	Pink, fine powder
Rose Essential Oil	Fragrance & antimicrobial	2 g	Light yellow liquid
Vitamin E (Tocopherol)	Antioxidant & preservative	1 g	Amber oily liquid
Distilled Water	Consistency adjustment	q.s.	Clear, colourless

4.2 Description of Ingredients

4.2.1 Sugar (Sucrose)

Fine-grade white sugar serves as the primary mechanical exfoliant in the formulation. Its crystalline granules provide gentle physical abrasion to remove keratinized dead cells from the stratum corneum without inducing micro-tears or irritation. Importantly, sucrose also exhibits humectant properties — its ability to form hydrogen bonds with water molecules helps the skin retain moisture during and after exfoliation. Being water-soluble, sugar dissolves upon contact with perspiration or rinse water, ensuring complete removal without leaving an abrasive residue [8].

4.2.2 Aloe Vera Gel

Aloe vera gel is extracted from the parenchymal tissue of Aloe barbadensis Miller leaves. Chemically, it is a complex mixture of polysaccharides (acemannan), glycoproteins (aloctins), anthraquinones (aloin), vitamins A, C, and E, and various minerals. In the formulation, aloe vera gel acts as the primary hydrating vehicle, providing a calming, anti-inflammatory, and wound-healing base that counterbalances the mild abrasive action of sugar. Its high water content (>95%) also contributes to the formulation's desired semi-solid consistency [5].

4.2.3 Coconut Oil

Cold-pressed virgin coconut oil is incorporated as the principal emollient and occlusive agent. Its unique fatty acid profile — comprising approximately 47–53% lauric acid, 15–22% myristic acid, and 6–10% capric acid — confers both potent moisturizing activity and innate antibacterial properties. Topically, coconut oil forms a hydrophobic film over the skin surface that reduces transepidermal water loss (TEWL) and restores the integrity of the lipid barrier. Its addition also improves the textural spreadability of the formulation and contributes to a smooth application feel [13].

4.2.4 Body Wash (Mild Cleansing Base)

A pH-balanced, paraben-free mild body wash serves as the cleansing foundation of the formulation. It facilitates the emulsification of skin oils, environmental particulates, and the scrub itself during the rinsing process, ensuring thorough removal without disrupting the skin's acid mantle. The surfactant system of the body wash also contributes to the stable suspension of particulate exfoliants within the formulation, preventing sedimentation during storage [4].

4.2.5 Freeze-Dried Strawberry Powder

Freeze-drying technology preserves the full complement of bioactive constituents in fresh strawberries, including ellagic acid, anthocyanins (pelargonidin), ascorbic acid (vitamin C), and naturally occurring alpha-hydroxy acids (AHAs) such as malic acid. In the formulation, the fine particles of strawberry powder provide supplementary mild mechanical exfoliation while the AHAs facilitate gentle chemical exfoliation at the skin surface. Vitamin C and ellagic acid additionally inhibit tyrosinase activity, contributing to skin brightening

effects. The natural pink coloration of the powder imparts an aesthetically appealing hue to the finished product [6].

4.2.6 Rose Essential Oil

Steam-distilled rose essential oil (Rosa damascena) is incorporated at a concentration of 2% w/w for its therapeutic fragrance and documented biological activities. Its principal active constituents — geraniol, citronellol, linalool, and nerol — exhibit antibacterial activity against a broad spectrum of skin pathogens, including Staphylococcus aureus and Propionibacterium acnes. Rose oil also exerts anti-inflammatory effects and has been associated with anxiolytic and mood-enhancing properties upon inhalation, enhancing the holistic sensory experience of the product [14].

4.2.7 Vitamin E (dl-Tocopherol)

Vitamin E, in its tocopherol form, is included as a fat-soluble antioxidant. It fulfills a dual role: as a skin-active ingredient, it neutralizes reactive oxygen species (ROS) generated by UV radiation and environmental pollutants, thereby reducing oxidative skin damage and delaying signs of photoaging; as a formulation excipient, it protects the unsaturated fatty acids in coconut oil from auto-oxidative rancidity, thereby extending the product's shelf life and maintaining olfactory integrity [16].

4.2.8 Distilled Water

Pharmaceutical-grade distilled water is added in minimal quantity to achieve the desired semi-solid consistency and facilitate the uniform dispersion of all ingredients. The use of distilled water — free from ionic contaminants and microorganisms — prevents premature degradation of formulation components and ensures the accuracy of pH measurements. Excessive water addition is deliberately avoided to minimize the risk of microbial proliferation during storage [1].

V. METHOD OF PREPARATION

The herbal body scrub was prepared using a simple, scalable, and cost-effective procedure under controlled room-temperature conditions (25 ± 2 °C). All equipment was cleaned, sanitized with 70% isopropyl alcohol, and dried prior to use to prevent microbial contamination. The following stepwise procedure was followed to ensure homogeneous blending, optimal consistency, and stability of the final formulation [11].

5.1 Step-by-Step Procedure

Step 1 — Accurate Weighing of Ingredients

All ingredients were accurately weighed to the nearest 0.01 g using a calibrated analytical balance. The quantities used for the standard formulation (Batch 4) were: sugar 40 g, aloe vera gel 20 g, coconut oil 15 g, body wash 15 g, strawberry powder 5 g, rose oil 2 g, vitamin E 1 g, and distilled water q.s. Weighing was repeated three times per ingredient to confirm accuracy.

Step 2 — Preparation of Exfoliating Base

Precisely weighed sugar was transferred to a clean, dry glass beaker. Freeze-dried strawberry powder was added in small increments with continuous geometric trituration using a stainless-steel spatula until a homogeneous exfoliating blend of uniform pink-brown color was obtained. Geometric dilution prevents particle agglomeration and ensures even distribution of the fine strawberry particles throughout the coarser sugar matrix.

Step 3 — Incorporation of Moisturizing Agents

Coconut oil — previously warmed to 30 °C to achieve a fluid, pourable consistency — was added to the exfoliating base in a thin, steady stream while stirring continuously in a single direction. This ensures thorough coating of sugar particles with the lipid phase, improving cohesion of the mixture. Subsequently, aloe vera gel was incorporated in incremental portions with gentle stirring until a smooth, homogeneous, semi-solid mass was obtained.

Step 4 — Addition of Cleansing Base

The measured quantity of mild body wash was added gradually to the moisturizer-enriched exfoliating mixture with constant, gentle stirring. The body wash serves as the aqueous-surfactant phase that stabilizes the lipid-aqueous interface and imparts appropriate cleansing properties to the formulation. Excessive agitation was avoided to prevent aeration and incorporation of air bubbles into the final product.

Step 5 — Addition of Active and Functional Excipients

Vitamin E oil was first dissolved uniformly in a portion of the coconut oil phase and then incorporated into the bulk mixture to ensure complete solubilization in the lipid fraction. Rose essential oil was then added dropwise from a calibrated glass dropper with gentle folding of the mixture to achieve uniform distribution without volatilization loss.

Step 6 — Consistency Adjustment

If the resulting formulation did not meet the target semi-solid consistency — defined as flowing smoothly under its own weight but not separating upon standing — small, incremental volumes of distilled water (0.5 mL per addition) were incorporated with mixing until the desired rheological profile was attained.

Step 7 — Final Blending, Inspection, and Packaging

The final formulation was subjected to visual inspection for color uniformity, absence of phase separation, texture consistency, and characteristic fragrance. The product was then transferred into clean, amber-colored airtight glass jars to minimize exposure to light, moisture, and oxygen. Each container was labeled with the batch number, preparation date, storage conditions, and ingredient list.

5.2 Precautions Observed During Preparation

1. All glassware and equipment were sterilized prior to use to minimize microbial contamination.
2. Ingredients were incorporated in the specified sequence to ensure complete phase compatibility and uniform dispersion.
3. Mixing was performed gently and directionally to prevent aeration of the product.
4. Rose essential oil was added last and in minimum quantity to prevent volatilization and skin sensitization.
5. Distilled water addition was kept to the minimum required to achieve the desired consistency.
6. Products were stored in sealed, amber containers in a cool, dark location immediately after preparation.

VI. EVALUATION PARAMETERS

A comprehensive quality evaluation protocol was established to assess the physicochemical properties, safety, stability, and performance of all four prepared batches. Each parameter was assessed according to methods described in standard cosmetic and pharmaceutical references [4, 21]. Results for all batches are presented comparatively, with Batch 4 serving as the standard reference formulation.

6.1 Physical Appearance and Organoleptic Properties

Visual examination under standardized white illumination was conducted to assess color, odor, texture, and overall appearance. An ideal formulation should display a uniform pinkish-brown color (characteristic of strawberry and sugar blend), a pleasant rose fragrance, a smooth semi-solid consistency with evenly dispersed exfoliating particles, and the complete absence of phase separation, visible agglomerates, or foreign particulates. Odor was assessed by five trained panelists using a 5-point Likert scale (1 = very unpleasant; 5 = very pleasant).

6.2 pH Determination

pH was measured using a calibrated digital pH meter (Hanna Instruments, HI98100) after preparing a 1% w/v aqueous dispersion of the scrub in freshly boiled and cooled distilled water. Measurements were performed in triplicate at 25 ± 0.5 °C. The skin's physiological pH ranges from 4.5 to 6.5; cosmetic formulations falling within this range minimize the risk of barrier disruption and microbial colonization. Deviations beyond this range were recorded as non-compliant.

6.3 Spreadability

The glass slide method was employed to quantify spreadability. A uniform 0.5 g quantity of the scrub was placed between two pre-cleaned glass slides, and a standard weight of 500 g was applied for 5 minutes. The diameter of the resulting spread was measured using a calibrated ruler in two perpendicular axes, and the mean area (cm^2) was calculated. Higher spreadability values indicate superior application characteristics and better product coverage per unit dose [17].

6.4 Homogeneity

Homogeneity was assessed both visually and by finger-smear technique, in which a small quantity of the scrub was rubbed between the thumb and forefinger and examined for the presence of agglomerates, lumps, or unevenly distributed particles. A homogeneous formulation ensures consistent delivery of both exfoliating particles and active moisturizing agents across the skin surface.

6.5 Washability

A standardized washability assessment was conducted by applying 2 g of the scrub to the volar forearm of five volunteer subjects, followed by gentle massage for 60 seconds and rinsing under lukewarm running water for 30 seconds. Residue, texture feel, and skin softness post-wash were evaluated on a 5-point scale by the investigator and the subject. Ease of removal, absence of greasy residue, and a smooth post-wash skin feel were considered satisfactory outcomes.

6.6 Viscosity

Apparent viscosity was determined at 25 ± 0.5 °C using a Brookfield Viscometer (DV-E model) at 10 rpm with spindle S4. Three consecutive readings were recorded and averaged. The target viscosity range for a body scrub suitable for tube or jar packaging was defined as 10,000–18,000 cP, based on literature values for commercially acceptable semi-solid cosmetics [18].

6.7 Skin Irritation Test (Patch Test)

A 48-hour occlusive patch test was conducted in compliance with ISO 10993-10 and the Draize dermal irritation protocol on five consenting volunteers with no history of skin allergy [19]. Approximately 0.5 g of each formulation was applied under occlusion to a 2 × 2 cm area on the volar forearm. The site was inspected at 24 h and 48 h for erythema, edema, papules, vesicles, or subjective pruritus. Results were scored using the Primary Irritation Index (PII): PII < 0.5 = negligible; 0.5–1.9 = mild; 2.0–4.9 = moderate; ≥ 5.0 = severe.

6.8 Stability Studies

Stability was assessed in accordance with ICH Q1A(R2) guidelines [20]. Samples from each batch were stored at three temperature conditions: (i) refrigerated at 4 °C ± 2 °C; (ii) ambient at 25 °C ± 2 °C / 60% RH; and (iii) accelerated at 45 °C ± 2 °C / 75% RH. Samples were withdrawn at Day 0, Day 15, and Day 30 and evaluated for color, odor, pH, phase separation, and texture.

6.9 Particle Size and Grittiness

The mean particle size of exfoliating granules was measured using laser diffraction (Malvern Mastersizer 3000) in triplicate. A target size range of 250–500 µm was defined as optimal, providing effective but non-traumatic mechanical exfoliation. Grittiness was concurrently assessed by five panelists using a 5-point scale (1 = not gritty; 5 = very coarse). A score ≤ 2 was considered acceptable.

6.10 Moisturizing Efficacy

Skin hydration was assessed before and 1 h after a single application of the scrub using a Corneometer CM825 (Courage + Khazaka, Germany), which measures skin capacitance as a surrogate for water content. Results were expressed as arbitrary Corneometer Units (CU). A statistically significant increase in CU post-application was considered indicative of effective moisturization.

6.11 Extrudability

Extrudability was assessed by filling a standardized aluminum tube with the formulation and recording the mass extruded per application of a defined force (1 kgf for 5 seconds) using an Instron Universal Testing Machine. A minimum extrusion of 0.5 g per application was considered satisfactory for product usability.

VII. TEST RESULTS AND DISCUSSION

7.1 Batch Compositions and Deviations

Four batches were prepared, with Batch 4 representing the optimized standard formulation. Batches 1 through 3 incorporated deliberate compositional deviations to allow a systematic comparative evaluation of the impact of ingredient ratios on the final product's quality attributes.

Table 2: Batch Compositions and Observed Deviations

Batch	Deviation from Standard	Observed Results	Inference
Batch 1	Higher sugar proportion (50 g vs 40 g)	Coarser texture, off-white colour, higher pH (6.8), skin irritation in 2/5 subjects, phase separation at 45 °C	Excess abrasive; pH outside optimal range (4.5–6.5); unstable at elevated temperature
Batch 2	Reduced coconut oil (8 g) & higher aloe vera (28 g)	Slightly gritty, less moisturising, mild rose odour, stable	Lower lipid content reduces emolliency; formulation still acceptable overall
Batch 3	Excess rose oil (5 g) & lower sugar (32 g)	Overpowering fragrance, slightly oily, lower exfoliating efficacy, pH 4.2 (borderline)	High essential oil concentration risks sensitization; reduced exfoliation efficacy
Batch 4 (Standard)	Optimal ratio as per formulation table	Smooth pinkish-brown texture, pleasant rose scent, pH 5.5, no irritation, stable under all conditions	All parameters within accepted cosmetic standards; recommended formulation

7.2 Comprehensive Evaluation Results — All Batches

The following table presents the complete evaluation data for all four batches across all assessment parameters. Batch 4 (Standard) demonstrates consistent compliance with all quality criteria, while Batches 1–3 exhibit parameter-specific deviations corresponding to their compositional modifications.

Table 3: Comprehensive Evaluation Results — All Batches

Evaluation Parameter	Batch 1 (Deviated)	Batch 2 (Deviated)	Batch 3 (Deviated)	Batch 4 ★ (Standard)
Physical Appearance	Slightly grainy, off-white	Light pink, uniform	Pink, slight oiliness	Smooth, pinkish-brown, uniform
Colour	Off-white	Light pink	Pink	Pinkish-brown
Odour	Faint, mild	Mild rose	Strong rose, overpowering	Pleasant rose, characteristic
Texture	Rough, coarse	Slightly gritty	Smooth	Smooth & uniform
pH	6.8	5.2	4.2	5.5
Spreadability (g·cm/s)	8.2	11.5	13.8	10.4
Homogeneity	Non-uniform, clumps	Uniform	Uniform	Perfectly uniform
Washability	Slight residue	Easy rinse	Easy rinse	Easy, no residue
Viscosity (cP)	18,500	12,400	9,800	14,200
Stability (45 °C/1 mo)	Phase separation	Stable	Minor odour change	Stable, no change
Stability (4 °C/1 mo)	Hardened	Stable	Stable	Stable
Irritation (Patch Test)	Mild erythema (2/5 subjects)	No irritation	No irritation	No irritation
Particle Size (µm)	650–900	280–420	250–380	300–450
Grittiness	Coarse (5/5)	Mild (2/5)	Mild (1/5)	Mild (1/5)

Moisturising Effect	Poor (over-dry)	Good	Adequate	Excellent
Extrudability	Difficult	Easy	Easy	Easy
Microbial count (CFU/g)	1.8×10^3	4.2×10^2	3.1×10^2	1.5×10^2
Overall Compliance	FAIL	PASS	PASS	PASS (Standard)

7.3 Stability Study Results (Batch 4 — Standard)

The standard formulation (Batch 4) was subjected to comprehensive stability testing over a 30-day period under three storage conditions as per ICH Q1A(R2) guidelines. The formulation demonstrated excellent physicochemical stability across all conditions, with no observable change in color, no phase separation, a consistent pH of 5.5 ± 0.1, and microbial counts well within the acceptable cosmetic limit of ≤1000 CFU/g for topical preparations [20].

Table 4: Stability Study Results — Batch 4 (Standard)

Parameter	**Initial (Day 0)**	**4 °C (30 days)**	**25 °C ± 2 °C (30 days)**	**45 °C ± 2 °C (30 days)**
Colour	No change	No change	No change	No change
Odour	No change	No change	No change	No change
pH	5.5	5.5	5.6	5.5
Texture	No change	Slightly firm	No change	No change
Homogeneity	Uniform	Uniform	Uniform	Uniform
Phase Separation	None	None	None	None
Microbial	Pass	Pass	Pass	Pass

The deviation observed in Batch 1 — marked by coarse texture, elevated pH (6.8), and phase separation at 45 °C — can be attributed to the higher sugar content (50 g vs. 40 g standard), which disrupts the lipid-aqueous emulsion balance and increases the bulk particle size. The pH elevation beyond the recommended 4.5–6.5 range raises concerns about skin barrier disruption and altered microbial flora. Batch 2 presented a minor reduction in moisturization efficacy due to lower coconut oil content, but remained within acceptable limits for all other parameters. Batch 3's high rose oil concentration (5 g) resulted in an overpowering fragrance and a borderline-acidic pH of 4.2 that could potentially compromise enamel and mucous membrane safety upon accidental contact. Batch 4 (Standard) uniformly satisfied all quality criteria and is therefore identified as the optimized formulation.

VIII. ADVANTAGES AND DISADVANTAGES

A balanced appraisal of the herbal body scrub formulation, considering both its documented strengths and inherent limitations, is presented below.

Table 5: Advantages and Disadvantages of the Herbal Body Scrub

Advantages	**Disadvantages / Limitations**
Safe for all skin types, including sensitive skin	Shorter shelf life compared to synthetic products
Natural exfoliation without skin damage	Higher susceptibility to microbial contamination
Deep moisturization from coconut oil & aloe vera	Batch-to-batch variability in natural ingredients
Antioxidant protection from Vitamin E & strawberries	Possible allergic reactions in sensitive individuals
Pleasant fragrance and sensory appeal from rose oil	Requires careful storage (cool, dark, airtight)
Eco-friendly and biodegradable formulation	Limited preservative system without synthetics

Cost-effective with readily available ingredients	Seasonal availability of some natural ingredients
Free from parabens, sulfates, and artificial dyes	Lack of stringent regulatory approval pathways

IX. APPLICATIONS OF HERBAL BODY SCRUB

The multifunctional nature of the herbal body scrub formulation — combining exfoliating, moisturizing, antioxidant, cleansing, and sensory properties — lends itself to a broad range of dermatological and cosmetic applications, as summarized in Table 6.

Table 6: Applications of Herbal Body Scrub

Application Area	Description	Target Use
Daily Skincare	Routine exfoliation to remove dead cells, unclog pores, and improve skin texture for a natural glow	Suitable for all skin types
Spa & Beauty Therapy	Body polishing treatments in salons and wellness centres for skin rejuvenation	Professional skin care
Post-Hair Removal	Helps prevent ingrown hairs and soothes skin after shaving or waxing	Underarm, leg & bikini area
Hyperpigmentation	Natural AHAs from strawberry assist in gentle lightening of dark spots and uneven tone	Face & body application
Blood Circulation	Massaging action improves microcirculation, delivering nutrients to skin cells	Anti-ageing benefit
Dry Skin Management	Emollient blend of coconut oil & aloe vera restores skin moisture and barrier function	Elbows, knees, heels
Aromatherapy Add-on	Rose essential oil provides a relaxing, stress-reducing sensory experience	Wellness & mental health

X. CONCLUSION

The present investigation successfully achieved the formulation and comprehensive evaluation of a herbal body scrub using an evidence-based selection of natural ingredients — sugar, aloe vera gel, coconut oil, body wash, freeze-dried strawberry powder, rose essential oil, vitamin E, and distilled water. Four batches (B1–B4) were systematically prepared and evaluated, incorporating compositional deviations in Batches 1–3 to elucidate the influence of ingredient ratios on product quality.

Batch 4, representing the optimized standard formulation, demonstrated consistent compliance with all physicochemical quality parameters across evaluation criteria: a skin-compatible pH of 5.5; a smooth, uniform, pinkish-brown texture; a spreadability value of 10.4 g·cm/s; viscosity of 14,200 cP within the optimal rheological range; complete homogeneity; ease of washability without residue; and excellent stability under all ICH-specified storage conditions. Patch test results confirmed the absence of dermal irritation in all subjects, and microbial counts were well within the acceptable cosmetic safety limit.

In contrast, Batch 1 (excess sugar) exhibited a non-compliant pH, coarse texture, phase instability, and mild dermal irritation; Batch 2 (reduced coconut oil) showed reduced moisturizing efficacy; and Batch 3 (excess rose oil) presented an overpowering fragrance and borderline-low pH. These comparative findings validate the critical importance of maintaining precise ingredient ratios in herbal cosmetic formulations.

Collectively, the study demonstrates that the herbal body scrub is a safe, effective, and economical alternative to commercially available synthetic scrubs, offering the added benefits of eco-friendliness, biodegradability, and compatibility with sensitive skin. The formulation holds strong promise for commercialization, subject to scale-up studies, extended stability testing, and registration under applicable cosmetic regulatory frameworks.

XI. FUTURE SCOPE

The present study provides a robust scientific foundation for the future development and commercialization of herbal body scrub formulations. Several promising research directions are identified for subsequent investigation:

1. Incorporation of natural preservative systems — including neem leaf extract, rosemary oleoresin, and phenoxyethanol at permissible limits — to extend microbiological shelf life without compromising the herbal nature of the product.
2. Extended stability studies over 12 and 24 months under real-time and accelerated conditions, with parallel microbiological challenge testing, to formally establish shelf life claims for regulatory submission.
3. Clinical randomized controlled trials (RCTs) on a larger and more diverse study population to generate statistically validated efficacy and safety data for dermatological certification.
4. Exploration of additional bioactive botanical ingredients — including turmeric (curcumin), neem (azadirachtin), coffee (caffeine), and green tea polyphenols — to extend the therapeutic indications of the formulation.
5. Investigation of novel delivery systems, including microencapsulation of essential oils and antioxidants, to improve bioavailability, control release, and photostability.
6. Scale-up feasibility studies for commercial manufacturing, including development of Good Manufacturing Practice (GMP)-compliant production protocols and packaging optimization.
7. Environmental impact assessment of raw material sourcing and product lifecycle to formalize the formulation's claim as a sustainable, eco-certified cosmetic product.

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