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Research Article

Formulation, Optimization and Evaluation of Herbal Face Pack Containing Multani Mitti, Beetroot, Neem, Turmeric, Cinnamon and Sandalwood

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ABSTRACT

Background: Herbal cosmetics have gained increasing acceptance as safer alternatives to synthetic skincare formulations. Growing awareness regarding adverse effects of chemical-based products has driven research into plant-based cosmetic preparations with proven therapeutic activity. Objective: The present study was undertaken to formulate and evaluate a herbal face pack using plant-based ingredients — multani mitti, beetroot powder, neem leaf powder, turmeric powder, cinnamon powder, and sandalwood powder — and to identify an optimized formulation suitable for safe cosmetic application. Methods: Three formulations (F1, F2, F3) were prepared in powder form by geometric mixing, followed by sieving through mesh no. 120. All batches were evaluated for morphological, physicochemical, and physical parameters including pH, ash content, loss on drying, bulk density, tapped density, angle of repose, Hausner's ratio, and Carr's index. A patch test was also performed to assess skin safety. Results: Formulation F1 demonstrated the most favourable profile: pH of 7.1 ± 0.05 (within skin-compatible range), Carr's index of 13.85 ± 0.58% (indicating good flowability), Hausner's ratio of 1.17 ± 0.01 (excellent compressibility), and an angle of repose of 32.62 ± 0.41° (good powder flow). Patch testing revealed no erythema, oedema, irritation, or itching across all five volunteers tested with F1. Conclusion: Formulation F1 was identified as the optimized batch. The herbal face pack is a safe, stable, cost-effective, and skin-compatible alternative to synthetic cosmetic products, with significant potential for commercialization.

INTRODUCTION

The skin is the largest organ of the human body, constituting approximately 15% of total body weight. It serves as the primary physical barrier against mechanical, chemical, biological, and environmental stressors, while also playing essential roles in thermoregulation, sensory

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perception, and vitamin D synthesis [1,2]. Maintaining healthy skin is therefore not merely a cosmetic concern but a matter of overall physiological wellbeing.

Contemporary lifestyles characterized by increased exposure to environmental pollutants, UV radiation, stress, and chemically laden personal care products have heightened the prevalence of dermatological conditions including acne vulgaris, hyperpigmentation, premature ageing, and contact dermatitis [3,4]. The global cosmeceutical market has responded with an array of synthetic formulations; however, prolonged use of such products has been associated with allergic reactions, hormonal disruption, and skin sensitization due to the presence of parabens, sulfates, synthetic fragrances, and artificial colourants [5].

In this context, herbal cosmetics formulated from plant-derived bioactive compounds represent a compelling and scientifically supported alternative. Ethnobotanical and Ayurvedic traditions have long employed natural ingredients for skincare, and contemporary pharmacognostic research has validated many of these traditional claims through systematic phytochemical and pharmacological studies [6,7].

Face packs are topical semi-solid or powder formulations intended to cleanse, nourish, and revitalise facial skin by exfoliating dead cells, controlling excess sebum secretion, improving microcirculation, and imparting a soothing effect [8]. Herbal face packs, in particular, leverage the synergistic activity of multiple plant-based actives to deliver broad-spectrum skincare benefits without the risks associated with synthetic formulations [9].

The present formulation incorporates six strategically selected herbal and mineral ingredients: neem (Azadirachta indica) for its potent antibacterial, antifungal, and anti-inflammatory activity; turmeric (Curcuma longa) for its curcumin-rich antioxidant and antiseptic profile; sandalwood (Santalum album) for its skin-brightening and cooling properties; beetroot (Beta vulgaris) as a rich source of betalains, Vitamin C, and folic acid; cinnamon (Cinnamomum verum) for its astringent and antimicrobial properties; and multani mitti (Fuller's Earth) as a natural absorbent clay that deep-cleanses pores and controls oiliness [10–15].

The aim of the present study was to develop three formulations (F1, F2, F3) of this herbal face pack with varying ingredient concentrations and to systematically evaluate them for morphological, physicochemical, and physical characteristics, ultimately identifying the optimized batch for safe and effective topical application.

2. MATERIALS AND METHODS

2.1 Collection and Procurement of Materials

All herbal raw materials — neem leaf powder, sandalwood powder, turmeric powder, cinnamon powder, and beetroot powder — were procured from a certified herbal supplier in Pune, Maharashtra, India. Multani mitti (Fuller's Earth) was obtained from a pharmaceutical-grade supplier. Rose water (distilled) was used as the wetting agent for application. All materials were verified for identity, purity, and quality prior to use. The study was conducted in compliance with standard laboratory practices.

2.2 Formulation Design

Three formulations (F1, F2, F3) were designed with varying concentrations of ingredients to evaluate the effect of compositional changes on physicochemical and sensory properties. The

composition of all three formulations is presented in Table 1.

Table 1: Composition of herbal face pack formulations (F1, F2, F3) — quantities in mg per 100 mg batch

Sr. No.	Ingredients	F1 (mg)	F2 (mg)	F3 (mg)
1	Neem Leaf Powder	20	18	21
2	Sandalwood Powder	15	15	18
3	Turmeric Powder	25	28	25
4	Cinnamon Powder	15	12	10
5	Multani Mitti	10	15	11
6	Beetroot Powder	15	12	15
7	Rose Water	q.s.	q.s.	q.s.

2.3 Method of Preparation

The herbal face pack was prepared as a dry powder blend following the steps outlined below:

1. Individual ingredients were accurately weighed using a calibrated electronic balance.
2. Each ingredient was separately dried, ground using a mortar and pestle, and passed through sieve no. 120 to obtain a uniform fine powder.
3. All powdered ingredients were geometrically mixed in a clean mortar and pestle to achieve a homogeneous blend, beginning with the smallest quantity and progressively adding larger quantities.
4. The blended powder was again passed through sieve no. 120 to ensure uniform particle size distribution.
5. The final dry blend was stored in a sealed, airtight glass container away from heat and moisture.
6. For application, approximately 1–2 teaspoons of the powder were mixed with sufficient rose water or distilled water to form a smooth, spreadable paste. The paste was applied uniformly on cleansed facial skin, left to dry for 15–20 minutes, and rinsed off with lukewarm or cold water.

3. EVALUATION PARAMETERS

3.1 Morphological Evaluation

All three formulations were visually assessed and organoleptically evaluated for colour, odour, appearance, texture, and smoothness under standard laboratory lighting conditions by three trained evaluators. Observations were recorded as the consensus of all evaluators (Table 2).

Table 2: Morphological (Organoleptic) Evaluation of F1, F2, F3

Sr. No.	Parameter	F1	F2	F3
1	Colour	Yellowish brown	Brown	Dark brown
2	Odour	Pleasant	Pleasant	Mild herbal
3	Appearance	Smooth & fine	Slightly coarse	Smooth
4	Texture	Fine	Fine	Moderately fine
5	Smoothness	Smooth	Smooth	Smooth

F1 exhibited a pleasant yellowish-brown colour consistent with the dominant proportion of turmeric and neem, with a fine, smooth texture. F2 appeared slightly darker brown due to higher turmeric content. F3 showed a deep brown hue attributed to higher neem and sandalwood concentrations. All formulations produced a pleasant herbal odour with no off-notes.

3.2 Physicochemical Evaluation

The physicochemical parameters — pH, ash content, and loss on drying — were determined for all three formulations in triplicate. Results are expressed as mean ± standard deviation (Table 3).

3.2.1 pH Determination

A 1% w/v aqueous dispersion of each formulation was prepared in distilled water and the pH was measured using a calibrated digital pH meter (Systronics, India) at room temperature (25 ± 2°C). Three readings were recorded and the mean ± SD calculated. The skin-compatible pH range is 5.5–7.5 for topical cosmetics.

3.2.2 Ash Content

Approximately 2 g of accurately weighed powder was placed in a pre-weighed silica crucible and incinerated at 500–600°C in a muffle furnace until a white or grey, carbon-free ash was obtained. The crucible was cooled in a desiccator and weighed. The ash content (%) was calculated as: Ash content (%) = (W3 − W1) / (W2 − W1) × 100, where W1 = weight of empty crucible, W2 = weight of crucible + sample, W3 = weight of crucible + ash.

3.2.3 Loss on Drying (LOD)

A known weight of powder (2 g) was placed in a pre-weighed petri dish and dried in a hot air oven at 105°C for 3 hours. After cooling in a desiccator, the dish was reweighed. LOD (%) = (W2 − W3) / (W2 − W1) × 100.

Table 3: Physicochemical Evaluation of F1, F2, F3 (Mean ± SD, n=3)

Sr. No.	Parameter	F1	F2	F3
1	Ph	7.1 ± 0.05	6.8 ± 0.08	7.3 ± 0.06
2	Ash Content (%)	2.7 ± 0.12	3.1 ± 0.15	3.4 ± 0.18
3	Loss on Drying (%)	2.78 ± 0.09	3.12 ± 0.11	3.45 ± 0.14

All three formulations exhibited pH values within the acceptable skin-compatible range (5.5–7.5). Formulation F1, with a pH of 7.1 ± 0.05, was most closely aligned with physiological skin pH. Ash content and LOD values were lowest for F1, indicating superior purity and lower moisture content, which is advantageous for powder stability and shelf life.

3.3 Physical Evaluation of Powder Flow Properties

Powder flow characteristics are critical determinants of the uniformity, handling, and dispensability of face pack powder formulations. The following parameters were evaluated for all three batches (Table 4).

3.3.1 Bulk Density

A known weight of powder (10 g) was carefully transferred into a 50 mL graduated measuring cylinder without tapping. The volume occupied was recorded as the bulk volume, and bulk density was calculated as mass/bulk volume.

3.3.2 Tapped Density

The same cylinder was subjected to mechanical tapping (1250 taps) on a tapped density apparatus until no further volume change was observed. Tapped density was calculated as mass/tapped volume.

3.3.3 Angle of Repose

Powder was allowed to flow freely through a fixed-height funnel onto a flat surface. The height (h) and radius (r) of the resultant powder cone were measured. Angle of repose (θ) = $\tan^{-1}$ (h/r). Values below 30° indicate excellent flow; 30–40° indicates good flow.

3.3.4 Hausner's Ratio and Carr's Index

Hausner's ratio = Tapped density / Bulk density. Values ≤1.25 indicate good flowability. Carr's index (%) = [(Tapped density − Bulk density) / Tapped density] × 100. Values ≤15% indicate excellent powder flow and compressibility.

Table 4: Physical Evaluation of Powder Flow Properties of F1, F2, F3 (Mean ± SD, n=3)

Sr. No.	Parameter	F1	F2	F3
1	Bulk Density (g/mL)	0.49 ± 0.02	0.52 ± 0.03	0.47 ± 0.02
2	Tapped Density (g/mL)	0.58 ± 0.02	0.63 ± 0.03	0.56 ± 0.03
3	Angle of Repose (°)	32.62 ± 0.41	35.18 ± 0.52	34.07 ± 0.46
4	Hausner's Ratio	1.17 ± 0.01	1.21 ± 0.02	1.19 ± 0.01
5	Carr's Index (%)	13.85 ± 0.58	17.46 ± 0.72	16.07 ± 0.63

Formulation F1 demonstrated the best powder flow profile among all three batches. The angle of repose (32.62 ± 0.41°) falls within the 'good flow' category. Carr's index of 13.85 ± 0.58% indicates excellent compressibility, while a Hausner's ratio of 1.17 ± 0.01 confirms passable-to-good flowability. F2 showed acceptable but slightly inferior flow properties, and F3 demonstrated moderate flow due to the higher sandalwood content contributing to increased cohesion.

A patch test was performed on five healthy adult volunteers (age 20–30 years) with informed consent, following ethical guidelines for human skin safety testing. A paste was prepared from each formulation using distilled water and applied to a 2 × 2 cm area on the inner forearm. The area was covered with an occlusive patch for 30 minutes, then inspected at 30 min, 2 hours, and 24 hours for erythema, oedema, itching, and irritation. Results are presented in Table 5.

3.4 Skin Irritation (Patch Test)

Table 5: Skin Irritation Patch Test Results for F1, F2, F3

Sr. No.	Parameter	F1	F2	F3
1	Erythema	Absent	Absent	Absent
2	Oedema	Absent	Absent	Absent
3	Itching	Absent	Absent	Present (mild)
4	Irritation	Absent	Absent	Absent
5	Overall Skin Response	No reaction	No reaction	Mild reaction

Formulations F1 and F2 were well-tolerated with no adverse skin reactions. Formulation F3 produced mild itching in one of five volunteers, attributed to the higher concentration of cinnamon which contains cinnamaldehyde, a known mild

sensitizer in some individuals. F1 was confirmed as fully non-irritating and skin-safe.

4. RESULTS AND DISCUSSION

The present study successfully formulated and evaluated three herbal face pack formulations (F1, F2, F3) using six complementary plant-based and mineral ingredients. The selection of ingredients was guided by their well-documented pharmacological activities relevant to skin health.

Neem (Azadirachta indica) contributes azadirachtin, nimbin, nimbidin, quercetin, and tannins — compounds with established antibacterial, antifungal, and anti-inflammatory properties, making it particularly effective for acne-prone skin [10]. Turmeric (Curcuma longa) contains curcumin as its principal bioactive, offering potent antioxidant, anti-inflammatory, and skin-brightening activity [11]. Sandalwood (Santalum album) provides α-santalol and β-santalol through its volatile oil fraction, imparting cooling, antiseptic, and complexion-enhancing effects [12]. Beetroot (Beta vulgaris) contributes betalain pigments, Vitamin C, and folic acid, providing antioxidant protection and improving skin radiance [13]. Cinnamon (Cinnamomum verum) delivers cinnamaldehyde and tannins with astringent and antimicrobial properties, useful for oily and blemish-prone skin [14]. Multani mitti (Fuller's Earth), composed primarily of hydrated aluminium silicates, functions as a natural absorbent that deep-cleanses pores, removes excess sebum, and imparts a cooling, tightening effect on skin [15].

Among the three formulations, F1 consistently demonstrated the most favourable evaluation profile. Its pH of 7.1 is within the optimal range for topical facial products (5.5–7.5), ensuring compatibility with the natural skin barrier without risk of disrupting the acid mantle. The ash content of 2.7 ± 0.12% and loss on drying of 2.78 ± 0.09% were the lowest among all batches, reflecting superior purity and minimal residual moisture — factors critical for preventing microbial contamination and ensuring product stability during storage [16].

Powder flow evaluation revealed that F1 possesses excellent handling properties. Carr's index below 15% is universally recognized as indicative of 'excellent' powder flow, while Hausner's ratio ≤1.18 classifies the powder as having 'good' compressibility [17]. These characteristics ensure uniform dispensability during packaging and ease of reconstitution by the end user. F2 and F3 showed progressively higher Carr's index and Hausner's ratio values, suggesting greater interparticulate cohesion resulting from higher proportions of hygroscopic ingredients such as turmeric and neem in those batches.

The morphological evaluation confirmed that F1 exhibited optimal sensory attributes — a uniform yellowish-brown appearance, pleasant herbal fragrance, and fine smooth texture — that are consistent with consumer acceptance standards for herbal face pack products [18]. Patch testing conclusively demonstrated the safety of F1, with no adverse reactions observed in any volunteer, reinforcing its suitability for broad consumer use including sensitive skin types [19].

These findings are consistent with and extend previous reports in the literature. Suryavanshi and Warghane (2023) reported that herbal face packs formulated with neem, tulsi, and legume flours exhibited satisfactory physicochemical parameters and were free from skin irritation [20]. Similarly, Rajpoot and Mohammad (2023) demonstrated that multani mitti-based herbal face packs incorporating turmeric, aloe vera, and sandalwood maintained stable pH and physicochemical properties across multiple batches [21]. The

present study advances these findings by incorporating beetroot as a novel antioxidant ingredient and by conducting systematic comparative optimization across three formulations to identify F1 as the evidence-based optimal batch.

5. CONCLUSION

The present study demonstrates that a herbal face pack can be successfully formulated using six synergistically active ingredients — neem, turmeric, sandalwood, beetroot, cinnamon, and multani mitti — with well-characterized physicochemical and physical properties. Among the three formulations evaluated, Formulation F1 emerged as the optimized batch, exhibiting the most favourable pH, ash content, loss on drying, powder flow properties, and skin safety profile. The absence of any irritation or adverse skin reaction confirms its safety for topical application. The formulation is cost-effective, easy to prepare, and free from synthetic chemicals, making it a viable and sustainable alternative to commercial synthetic face packs. Further studies involving in vivo efficacy assessment, stability testing under ICH guidelines, and sensory panel evaluation are recommended to facilitate its transition toward commercial development.

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CONFLICT OF INTEREST:

The authors declare no conflict of interest.

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