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(RESEARCH ARTICLE)

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Development and evaluation of a mud-enriched face scrub for sebum control and skin cleansing

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Abstract

The present work focused on the formulation and evaluation of a mud-enriched face scrub designed for skin cleansing and sebum control. The formulation was prepared using a combination of natural and cosmetic ingredients, including Bhuna Chana peel powder as an exfoliating agent, Multani Mitti for oil absorption, Salicylic Acid for exfoliation and sebum management, Aloe vera for soothing effects, Carbomer 940 as a gelling agent, and moisturizing excipients such as Glycerin and Propylene Glycol. The prepared formulation was assessed for organoleptic characteristics, pH, spreadability, washability, grittiness, irritancy, and physical stability. The formulation showed acceptable appearance, satisfactory spreadability, easy washability, and good physical stability throughout the observation period. The pH of the formulation was recorded as 5.03, indicating suitability for skin application. No visible signs of irritation were observed after topical application. The findings suggest that the developed mud-enriched face scrub possesses appropriate characteristics for topical use and may serve as a potential formulation for skin cleansing and sebum management.

Keywords: Mud-Enriched Face Scrub; Sebum Regulation; Salicylic Acid; Multani Mitti; Bhuna Chana Peel; Skin Cleansing; Topical Formulation; Carbomer 940

1. Introduction

1.1. Background of Skin and Sebum Production

The skin is the largest organ of the human body and serves as a protective barrier against environmental damage, pathogens, and moisture loss. Sebaceous glands are an important component of the skin and contribute significantly to surface lipids through sebum secretion. Sebum, a complex lipid mixture produced through a holocrine mechanism, is released by the disintegration of sebocytes into the follicular duct. It plays a vital role in maintaining skin hydration, lubrication, and homeostasis while providing photoprotective, antioxidant, and antimicrobial functions. Sebum contains several lipid components, including triglycerides, fatty acids, wax esters, and squalene, which help preserve skin barrier integrity and protect against environmental stress. In addition, sebum facilitates the delivery of antioxidants such as vitamin E to the skin surface, thereby reducing oxidative damage. However, dysregulated or excessive sebum production may result in oily skin, enlarged pores, and other dermatological concerns, highlighting the need for effective topical formulations aimed at sebum regulation and pore management. (1–3)

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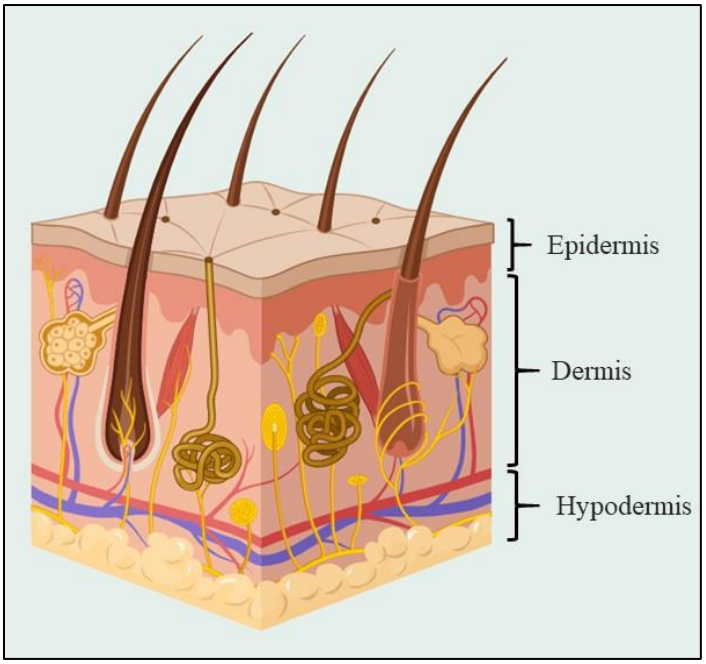


Figure 1 Human Skin Anatomy

1.2. Excess Sebum and Enlarged Pores: Causes and Effects

Excess sebum secretion is considered one of the major factors contributing to oily skin and enlarged facial pores. Increased sebaceous gland activity leads to excessive oil accumulation within the pilosebaceous unit, which may increase pore visibility and alter skin texture. In addition to excessive sebum production, reduced skin elasticity and increased follicular volume are also associated with pore enlargement. Furthermore, excessive sebum may accumulate with dead skin cells and environmental impurities within the pores, contributing to follicular blockage and enlargement of pores. Variations in the quantity and composition of sebum may further influence skin surface characteristics and contribute to dermatological concerns, particularly in oily and acne-prone skin. Consequently, effective sebum regulation, cleansing, and exfoliation strategies are essential for minimizing pore appearance, improving skin texture, and maintaining overall skin health (4–5).

1.3. Role of Mud in Skin Care and Sebum Control

Mud has been widely used in cosmetic and skincare applications due to its natural mineral composition and beneficial effects on skin health. Mineral-rich mud may support skin function by enhancing antioxidant activity and improving the overall condition of the skin. In addition, mud possesses absorbent properties that help remove excess oil, impurities, and environmental contaminants from the skin surface, thereby contributing to improved skin cleansing and sebum control. Certain naturally occurring microorganisms and minerals present in mud may also help support skin microbial balance and overall skin health. Owing to its natural origin, absorbability, and skin compatibility, mud has gained increasing attention as an important ingredient in skincare and cosmetic formulations aimed at improving skin texture and appearance (6). Mud and clay-based materials also exhibit significant oil-absorbing properties that contribute to sebum control. Their porous structure and cation exchange capacity enable the adsorption of excess skin lipids, exudates, and impurities from the skin surface, thereby reducing skin oiliness and supporting pore cleansing. These absorbent and astringent properties make mud-based formulations promising candidates for skincare applications aimed at controlling excess sebum and improving skin appearance. Additionally, mud-based skincare products may assist in gentle exfoliation by helping remove dead skin cells and surface impurities, thereby promoting smoother skin texture and cleaner pores (7).

1.4. Need for Mud-Enriched Face Scrub Formulation

The increasing demand for effective skincare products has highlighted the need for formulations capable of controlling excess sebum, cleansing pores, and improving skin texture. Mud and clay-based ingredients have gained attention in cosmetic and dermocosmetic formulations due to their beneficial properties, including sorption, cation exchange capacity, and physical exfoliation. These characteristics support the removal of excess oil, dead skin cells, and surface impurities while contributing to skin cleansing, barrier maintenance, and improved aesthetic appearance. Therefore,

mud-enriched face scrub formulations represent a promising approach for managing oily skin and minimizing enlarged pores (8–9).

1.5. Aim and Objectives of the Study

The present study was carried out with the following objectives:

- To formulate a mud-enriched face scrub containing natural and active ingredients, including Multani Mitti, Cicer arietinum, Aloe vera, and Salicylic Acid for controlling excess sebum and minimizing enlarged pores.
- To develop a cosmetically suitable scrub base using excipients such as Carbomer 940, Glycerin, and Propylene Glycol to achieve desirable consistency and skin compatibility.
- To evaluate the physicochemical properties of the formulated face scrub, including pH, spreadability, extrudability, and organoleptic characteristics.
- To assess the grittiness and washability of the formulation in order to determine its ease of application and skin-friendliness.
- To conduct stability studies of the developed formulation to evaluate its physical stability and storage performance over time.

2. Rationale for Selection of Formulation Ingredients

2.1. Multani Mitti (Fuller's Earth)

Multani Mitti (Fuller's Earth) is a mineral-rich natural clay widely used in skincare and cosmetic formulations because of its cleansing, purifying, and oil-controlling properties. It contains various beneficial minerals and clay components, including montmorillonite, smectite, bentonite, and magnesium compounds, which contribute to its dermatological effects. Multani Mitti helps remove excess oil, dirt, and skin impurities from the surface of the skin, thereby supporting skin cleansing and reducing oil accumulation. It may also assist in reducing blackheads, whiteheads, and acne commonly associated with oily skin. Furthermore, its cleansing and mild skin-purifying properties make it a suitable ingredient for scrub-based formulations intended for oily and impurity-prone skin. Owing to these beneficial properties, Multani Mitti was selected as a key ingredient in the present formulation for excess sebum control and pore minimization (10–11).

2.2. Cicer arietinum (Chickpea)

Cicer arietinum (Chickpea) is a natural ingredient traditionally used because of its beneficial biological properties. It contains various phytochemicals, including polyphenols and flavonoids, which contribute to its antioxidant and free radical scavenging activity. These properties may help protect the skin from oxidative stress and support overall skin health. In addition, chickpea has been traditionally used in topical and herbal skincare preparations. Therefore, *Cicer arietinum* was selected as an ingredient in the present formulation to support skin cleansing and enhance the effectiveness of excess sebum control and pore minimization (12).

2.3. Aloe vera

Aloe vera is widely used in skincare formulations because of its moisturizing, soothing, and skin-protective properties. It contains mucopolysaccharides that help retain moisture in the skin, thereby maintaining skin hydration and softness. In addition, Aloe vera exhibits mild anti-acne and skin-conditioning properties, which may help improve skin condition, particularly in oily and acne-prone skin. Aloe vera gel has also been reported to improve topical skin compatibility and maintain skin hydration during topical application. Therefore, Aloe vera was incorporated into the present formulation to minimize skin dryness and irritation associated with exfoliation while supporting excess sebum control and pore minimization (13–14).

2.4. Salicylic Acid

Salicylic acid is a widely used topical agent in skincare formulations because of its exfoliating, comedolytic, and sebum-regulating properties. Being a lipophilic compound, it can penetrate sebaceous follicles and interact with skin lipids, making it particularly beneficial for oily and acne-prone skin. Salicylic acid helps reduce excess sebum secretion and promotes exfoliation by decreasing corneocyte adhesion, thereby facilitating the removal of dead skin cells and surface impurities. These properties contribute to improved pore cleansing and reduction in pore blockage. Therefore, salicylic acid was incorporated into the present formulation to support excess sebum control and pore minimization (15).

2.5. Carbomer 940

Carbomer 940 is a high molecular weight cross-linked polymer of acrylic acid widely used in topical and cosmetic formulations as a gelling and thickening agent. It provides suitable viscosity and consistency to aqueous formulations, thereby improving spreadability and stability. In addition, Carbomer 940 helps maintain the uniform dispersion of active ingredients and scrub particles within the formulation. Therefore, Carbomer 940 was incorporated into the present formulation to develop a stable and cosmetically acceptable gel base for the mud-enriched face scrub (16).

2.6. Glycerin

Glycerin is widely used in topical and cosmetic formulations because of its humectant and moisturizing properties. It helps attract and retain moisture in the skin, thereby improving skin hydration and preventing excessive dryness. Glycerin also contributes to maintaining the moisture content of the stratum corneum and supports skin softness and barrier function. Therefore, glycerin was incorporated into the present formulation to minimize skin dryness and maintain skin hydration during exfoliation and excess sebum control (17).

2.7. Propylene Glycol

Propylene glycol is widely used in topical and cosmetic formulations as a co-solvent, humectant, and skin-conditioning agent. It helps improve the solubility and uniform distribution of poorly soluble active ingredients within the formulation and may enhance their topical delivery through the skin. In addition, propylene glycol contributes to maintaining formulation consistency and skin compatibility. Therefore, propylene glycol was incorporated into the present formulation to improve ingredient dispersion and support effective exfoliation and excess sebum control (18)

3. Materials and method

Table 1 The materials used in the formulation of mud-enriched face scrub are presented**.**

S. No.	Ingredient	Category/Function	Source
1.	Multani Mitti (Fuller's Earth)	Mud base, oil absorbent	Aminabad, Lucknow
2.	*Cicer arietinum* (Chickpea powder)	Natural exfoliant	Aminabad, Lucknow.
3.	*Aloe vera gel*	Skin soothing agent	Aminabad, Lucknow.
4.	Salicylic Acid	Keratolytic/Anti-acne agent	Laboratory
5.	Carbomer 940	Gelling agent	Laboratory
6.	Glycerin	Humectant	Procured from local market, Lucknow, India
7.	Propylene Glycol	Moisturizer / Solvent	Laboratory
8.	Methyl Paraben	Preservative	Laboratory
9.	Propyl Paraben	Preservative	Laboratory
10.	Triethanolamine (TEA)	pH adjuster	Laboratory
11.	Distilled Water	Vehicle	Laboratory
12.	Fragrance (if used)	Perfuming agent	Aminabad, Lucknow.

Table 2 Test Formula for Mud Enriched Face Scrub

S.No.	Name of Ingredient	Category / Phase	Quantity for 25g
1.	Purified Water (Aqua)	Aqueous Phase / Solvent	13.75ml
2.	Aloe Barbadensis Leaf Gel	Aqueous Phase / Active	2.5 ml
3.	Multani Mitti (Fuller's Earth)	Earth / Absorptive Phase	3.75 g
4.	Propylene Glycol	Solubilizer Phase	1 ml
5.	Glycerin	Humectant Phase	0.5 ml
6.	Bhuna Chana Peels (Sieved)	Exfoliant Phase	2.5 g
7.	Salicylic Acid	Active Chemical (BHA)	0.025 g
8.	Carbomer (Carbopol 940)	Polymer / Gelling Agent	0.175 g
9.	Triethanolamine (TEA)	Neutralizer	0.65 ml
10.	Fragrance (Perfume)	Organoleptic	1-2 drops
11.	Disodium EDTA	Chelating Agent	0.025 g
Total			25g

Table 3 Master Formula for Mud Enriched Face Scrub (100g Batch)

S.No.	Name of Ingredient	Category / Phase	Quantity for 100g
1.	Purified Water (Aqua)	Aqueous Phase / Solvent	65.0 ml
2.	Aloe Barbadensis Leaf Gel	Aqueous Phase / Active	10.0 ml
3.	Multani Mitti (Fuller's Earth)	Earth / Absorptive Phase	15 g
4.	Propylene Glycol	Solubilizer Phase	5.0 ml
5.	Glycerin	Humectant Phase	4.0 ml
6.	Bhuna Chana Peels (Sieved)	Exfoliant Phase	4.0 g
7.	Salicylic Acid	Active Chemical (BHA)	0.1 g
8.	Carbomer (Carbopol 940)	Polymer / Gelling Agent	1.0 g
9.	Triethanolamine (TEA)	Neutralizer	1.0 ml
10.	Fragrance (Perfume)	Organoleptic	2-4 drops
11.	Disodium EDTA	Chelating Agent	0.1 g
Total			100.0 g

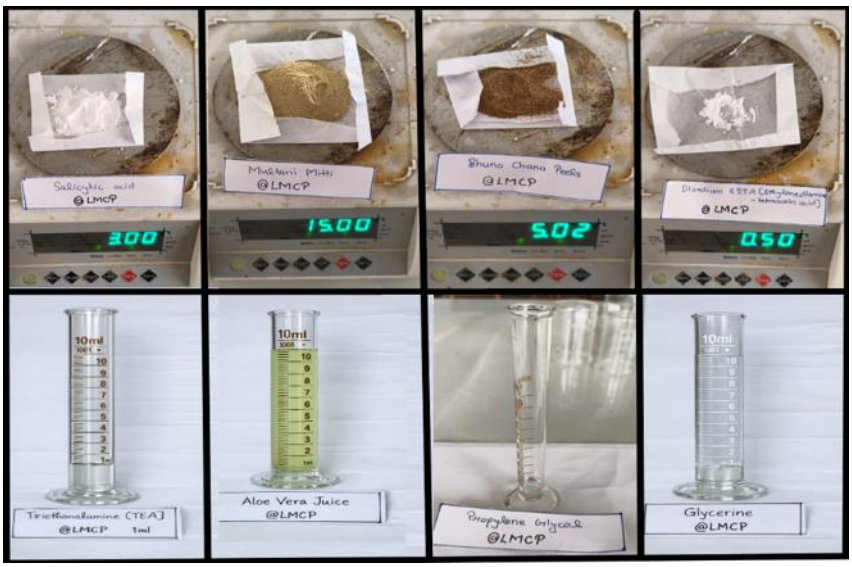
3.1. Method of Preparation of Mud-Enriched Face Scrub

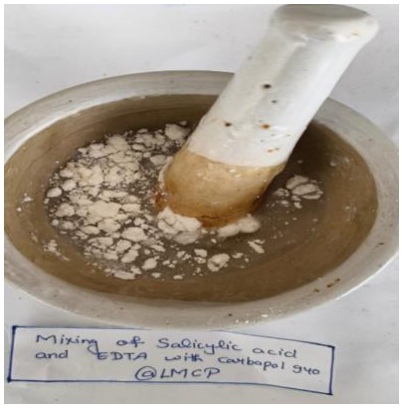
The mud-enriched face scrub was prepared using a dispersion method. All ingredients were collected and accurately weighed according to the formulation composition.

Initially, roasted chickpea peels (*Cicer arietinum*) were finely powdered using a grinder and sieved through a suitable mesh to obtain uniformly sized particles for mild exfoliating action.

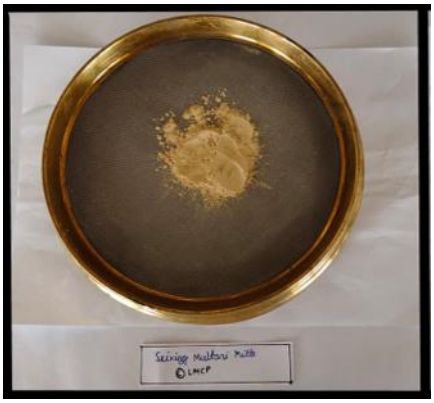
A measured quantity of purified water was taken in a clean beaker, and Carbopol 940 was gradually dispersed under continuous stirring to avoid lump formation. The dispersion was allowed to hydrate completely to obtain a uniform polymer base. Subsequently, salicylic acid, propylene glycol, glycerin, and disodium EDTA were added and mixed thoroughly.

Triethanolamine (TEA) was then added dropwise with continuous stirring to neutralize the Carbopol dispersion and obtain a suitable gel consistency. Thereafter, Multani Mitti and uniformly sieved chickpea peel powder were gradually incorporated into the gel base with continuous trituration to ensure homogeneous dispersion and uniform consistency. Finally, fragrance was added and mixed thoroughly. The prepared mud-enriched face scrub was transferred into suitable airtight containers, properly labelled, and stored for further evaluation studies.



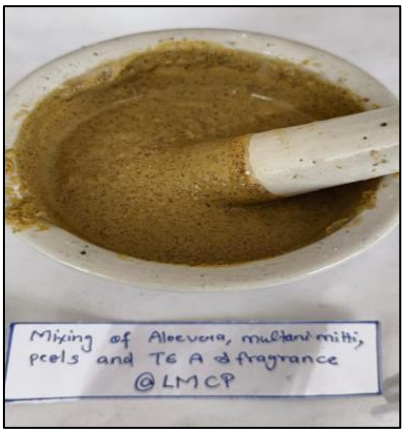


(A) Weighing of ingredients



(B) Grinding and sieving of roasted chickpea peel powder

(C) Preparation of Carbopol gel base



(D) Incorporation of Multani Mitti, Aloe vera, chickpea powder, and TEA

(E) Final mud-enriched face scrub formulation

Figure 2 Stepwise preparation of mud-enriched face scrub showing weighing of ingredients, grinding and sieving of roasted chickpea peel powder, preparation of gel base, incorporation of ingredients, and final formulation.

4. Evaluation of Face Scrub

The prepared mud-enriched face scrub was evaluated for various physicochemical and quality control parameters following standard cosmetic and pharmacopeial procedures.

4.1. Organoleptic Evaluation

The prepared formulation was evaluated for colour, odour, appearance, texture, and consistency by visual inspection to assess homogeneity and aesthetic acceptability.

4.2. pH Determination

The pH of the prepared mud-enriched face scrub was determined using a calibrated digital pH meter. Prior to measurement, the pH meter was standardized using standard buffer solutions at room temperature. A 1% w/v aqueous dispersion of the formulation was prepared using distilled water, and the pH was measured by immersing the electrode into the sample. The pH was evaluated to ensure compatibility with skin and suitability for topical application (19).

Figure 3 pH determination of prepared mud-enriched face scrub using a calibrated digital pH meter.

4.3. Spreadability Test

Spreadability of the prepared formulation was determined using the parallel plate method. A small quantity of the prepared face scrub was placed between two glass slides and compressed with a standard weight to evaluate the ease of spreading. The test was performed to assess uniform application, ease of use, and suitability of the formulation for topical application. Good spreadability is considered an important characteristic of semisolid formulations to ensure effective performance and uniform distribution over the skin surface (20).

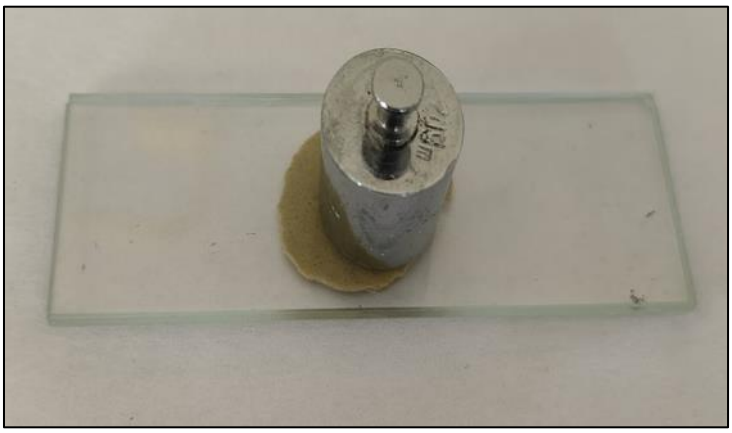


Figure 4 Spreadability test of prepared mud-enriched face scrub using parallel plate method

4.4. Washability Test

The washability of the formulation was evaluated by applying the scrub on the skin followed by washing with water to determine ease of removal and the absence of undesirable residue.

4.5. Grittiness Evaluation

The formulation was examined for the presence of uniformly distributed exfoliating particles to ensure effective mechanical exfoliation without excessive abrasiveness.

4.6. Irritancy Assessment

The prepared formulation was applied on a small area of skin to evaluate any signs of irritation, redness, itching, or discomfort after application.

4.7. Homogeneity

The formulation was visually inspected for uniform distribution of ingredients and absence of lumps or phase separation.

4.8. Stability Study

The stability of the prepared mud-enriched face scrub was evaluated under storage conditions to examine its physical integrity over time. The formulation was periodically assessed for changes in colour, odour, texture, consistency, homogeneity, and any evidence of phase separation. Stability evaluation was carried out to ensure that the formulation maintained acceptable physical characteristics and product uniformity during storage (21).

5. Results and Discussion

The prepared mud-enriched face scrub was successfully formulated and evaluated for various physicochemical parameters to determine its suitability for topical application and sebum regulation.

5.1. Organoleptic Evaluation

The prepared formulation was visually examined for colour, odour, texture, appearance, and consistency.

Table 4a Organoleptic Evaluation of Prepared Face Scrub

Parameter	Observation
Colour	Light brown
Odour	Characteristic
Appearance	Smooth mud like gel with scrub particle
Texture	Slightly gritty
Consistency	Semi solid

The formulation exhibited acceptable organoleptic characteristics with satisfactory consistency and uniform appearance. The exfoliating particles were uniformly distributed throughout the formulation, indicating proper incorporation of Bhuna Chana peel powder.

5.2. pH Determination

The pH of the prepared formulation was found to be 5.03.

Table 4b pH of Prepared Face Scrub

Parameter	Observation
pH	5.03

The pH of the prepared scrub was found to be within an acceptable range for topical skin application, indicating skin compatibility and suitability of the formulation (19).

5.3. Spreadability Test

The prepared formulation exhibited satisfactory spreadability.

Table 4c Spreadability of Prepared Face Scrub

Parameter	Observation
Spreadability	satisfactory

The formulation spread uniformly on the skin surface without excessive drag, indicating ease of application and suitable consistency for topical use (20).

5.4. Washability Test

The prepared formulation was easily washable with water and did not leave any undesirable residue on the skin surface after rinsing.

5.5. Grittiness Evaluation

The prepared scrub exhibited uniform distribution of exfoliating particles without excessive abrasiveness, suggesting suitability for mild exfoliation.

5.6. Irritancy Assessment

No redness, itching, or irritation was observed after application, indicating the suitability of the formulation for topical use.

5.7. Stability Study

No significant changes in colour, odour, texture, consistency, or phase separation were observed during the study period, indicating acceptable physical stability of the prepared formulation (21).

6. Discussion

The formulated mud-enriched face scrub exhibited favourable physicochemical properties for topical application. Organoleptic examination revealed a uniform, semi-solid gel–mud base with evenly distributed exfoliating particles, indicating proper mixing and incorporation of the formulation components. The pH of the formulation was found to be 5.03, which lies within an acceptable range for topical application and may support skin compatibility (19). In addition, the formulation demonstrated satisfactory spreadability, enabling uniform application over the skin surface without excessive resistance, an important characteristic for semisolid preparations (20). The formulation was easily washable and did not leave undesirable residue after rinsing. No visible signs of redness, irritation, or itching were observed following application, suggesting good tolerability. Furthermore, no noticeable changes in colour, odour, texture, consistency, or phase separation were observed during the stability period, indicating acceptable physical stability of the formulation (21). Overall, the developed face scrub demonstrated suitable properties for sebum regulation and skin cleansing.

7. Conclusion

In the present investigation, a mud-enriched face scrub was formulated using natural exfoliating materials and suitable cosmetic excipients for skin cleansing and sebum control. The developed formulation demonstrated favourable physicochemical properties, including an appropriate pH, satisfactory spreadability, easy washability, and absence of visible irritation during application. Furthermore, no noticeable changes in physical characteristics such as colour, odour, texture, and consistency were observed throughout the stability period, indicating acceptable formulation stability. Based on the obtained findings, the formulated face scrub may be considered suitable for topical use and has potential for supporting skin cleansing and sebum management.

Compliance with ethical standards

Disclosure of conflict of interest

The authors declare that there is no conflict of interest regarding this research work.

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