

Formulation of a body scrub with pumpkin juice (*curcubita moschata*) and coconut pulp (*cocos nucifera* L.) for enhanced skin exfoliation and antioxidant protection

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Abstract. This study aimed to develop a body scrub formulation combining pumpkin juice (*Curcubita moschata*) and coconut pulp (*Cocos nucifera* L.) to provide antioxidant protection, enhance exfoliation benefits, and ensure physical stability and user acceptability. Fresh pumpkin juice and dried coconut pulp were prepared as active ingredients. Four formulations with varying concentrations of coconut pulp (0%, 5%, 10%, and 15%) were combined with 20% pumpkin juice. The formulations were evaluated for physical appearance, homogeneity, pH, spreadability, emulsion type, irritation potential, and sensory qualities. All formulations were homogeneous, with pH values between 6.1 and 6.2, suitable for skin application. Spreadability ranged from 5.5 to 6.5 cm, meeting the standard criteria. No irritation was observed in any formulation. Sensory evaluations showed that the formulation with 15% coconut pulp (F3) was most preferred for its color, texture, and aroma. This study demonstrates that combining pumpkin juice and coconut pulp results in a stable, effective, and consumer-acceptable body scrub formulation, with potential for commercial applications in natural cosmetics.

1 Introduction

The skin, recognized as the largest organ of the human body, serves a crucial role as a protective barrier against a wide array of environmental stressors, while also being essential for maintaining physiological homeostasis and overall health [1]. To function optimally, healthy skin requires proper hydration, with at least 10% water content in its outermost layer being crucial for maintaining its structure and resilience [2]. Beyond its protective functions,

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skin condition also influences physical appearance, which can significantly affect an individual's self-confidence [3]. However, skin is vulnerable to damage from various factors, including dullness, roughness, dryness, and premature aging, much of which is driven by oxidative stress from free radicals [4].

Antioxidants play a key role in countering oxidative damage, neutralizing free radicals that contribute to skin aging and deterioration [5]. Although the body naturally produces some antioxidants, it often requires external sources to enhance skin protection and rejuvenation [6]. External skincare, particularly treatments targeting the skin's surface, is essential in maintaining its health and appearance [7]. One widely used skincare treatment is body scrubs, which offer exfoliating benefits by removing dead skin cells to reveal fresher, smoother skin [8].

In recent years, natural ingredients have gained attention for their potential benefits in skincare products [9]. Two such ingredients pumpkin (*Curcubita moschata*) and coconut pulp (*Cocos nucifera* L.) have shown promising results in body scrub formulations. Pumpkin is rich in potent antioxidants like vitamin C, vitamin E, and β -carotene, which help protect the skin from UV radiation and oxidative stress [10]. Meanwhile, coconut pulp, which is often discarded as waste after coconut milk extraction, offers an effective exfoliant with moisturizing properties due to its coarse texture, protein, low fat, and fiber content [11].

In line with these benefits, the demand for natural and eco-friendly skincare products has significantly shaped the landscape of cosmetic research and development. Consumers are increasingly seeking products derived from natural ingredients, perceiving them as safer and more environmentally friendly alternatives to synthetic options. This shift has led to an expansion of research focusing on plant-based compounds and sustainable by-products, aligning with consumer preferences for products that support both skin health and environmental responsibility. The cosmetic industry is now exploring diverse natural ingredients, not only for their effectiveness but also for their minimal environmental impact [12].

Despite its potential, coconut pulp remains underutilized in skincare formulations. Given its exfoliating texture and nutrient-rich profile, it presents an ideal component for enhancing body scrubs. Previous studies have shown the stability and efficacy of pumpkin-based scrubs in delivering antioxidant protection. Building on this foundation, this research aims to develop a body scrub that combines the antioxidant properties of pumpkin juice with the exfoliating and moisturizing benefits of coconut pulp. By formulating scrubs with varying concentrations of these natural ingredients, this study seeks to identify the optimal combination that maximizes both antioxidant benefits and exfoliation, resulting in a stable and effective body scrub.

2 Material and Method

2.1 Materials

The following equipment was used in this study: analytical scales, blender, oven (for drying), baking sheet, 40-mesh sieve, spatula, porcelain cup, measuring glass, beaker, glass object, petri dish, glass cover, mortar and pestle, stirring rod, parchment paper, labeling paper, plastic containers, pH meter, scoop, water bath, stopwatch, tissue, and microscope. The materials used in this study are pumpkin juice, coconut pulp, distilled water, cetyl alcohol, triethanolamine (TEA), propylene glycol, methyl paraben, stearic acid, pumpkin, methyl blue.

The choice of certain chemicals, such as Triethanolamine and Methyl paraben, was made based on their roles in stabilizing emulsions and preventing microbial contamination in

topical formulations. Triethanolamine acts as an emulsifier, while methyl paraben serves as a preservative to extend the shelf life of the product.

2.2 Metods

The research was conducted in July 2024 at the Harapan Bangsa University Research Laboratory. It used pumpkin samples obtained from pumpkin farms in Purbalingga City and coconut pulp, which is household waste, to make a body scrub formula.

2.3 Processing of Pumpkin Juice (*Curcubita moschata*)

The first step involved preparing 5 kg of fresh pumpkin, thoroughly washing the skin, and cutting it into small pieces. The pumpkin pieces were then blended until smooth, and the resulting puree was strained through a white cloth to obtain the juice. The juice was heated in a water bath at a temperature between 40°C and 60°C for approximately 2 hours to reduce water content and concentrate the active ingredients.

2.4 Processing of Coconut Dregs (*Cocos nucifera L.*)

To prepare the coconut pulp, 300 grams of coconut husk were cleaned, then pressed to separate the coconut water. The pulp was then dried in an oven at 40°C to 60°C for about 3 hours, reducing its moisture content. After drying, the coconut pulp was ground using a blender until a fine texture was achieved. The final step involved sieving the processed pulp through a 40-mesh sieve to achieve a smooth, uniform texture.

2.5 Formulation of Body Scrub Preparations

Table 1. Formulation of Body Scrub Preparations Used

No	Ingredient	Total (%)			
		F0	F1	F2	F3
1	Pumpkin juice	20	20	20	20
2	Coconut pulp	-	5	10	15
3	Cetyl Alcohol	1	1	1	1
4	Triethanolamine	0,5	0,5	0,5	0,5
5	Propylene glycol	5	5	5	5
6	Methyl paraben	0,3	0,3	0,3	0,3
7	Stearic acid	15	15	15	15
8	Aqua dest ad	100	100	100	100

Rationale for ingredient concentrations:

- Pumpkin juice was selected at a 20% concentration for all formulations, as previous studies showed that this concentration provides an optimal level of active ingredients such as beta-carotene and antioxidants.
- Coconut pulp concentrations (5%, 10%, and 15%) were chosen to investigate the effect of varying natural exfoliating agents on the physical and sensory properties of the body scrub and to optimize texture and exfoliation performance.

2.6 Procedure for Preparation of Body Scrub Cream Base

All ingredients were weighed according to the formulation. The oil phase, consisting of cetyl alcohol and stearic acid, was heated in a water bath at 70°C. Simultaneously, the aqueous phase, containing propylene glycol, triethanolamine, methyl paraben, and distilled water, was also heated to the same temperature. Once both phases reached the desired temperature, they were combined in a mortar and mixed for approximately 15 minutes to form a homogeneous mass [13].

2.7 Procedure for Making Body Scrub Cream Containing Pumpkin Juice and Coconut Dregs.

Weigh the pumpkin juice and coconut pulp to be used. Slowly add the pumpkin juice and coconut pulp into the cream base, a little at a time. Stir the mixture until evenly distributed and a homogeneous body scrub cream is formed. After that, put the body scrub cream into a container for storage.

2.8 Evaluation of Body Scrub Cream Preparations

The body scrub was evaluated for various physical and sensory properties, including organoleptic testing, homogeneity, pH, spreadability, emulsion type, irritation potential, and hedonic testing. The following criteria were used:

2.8.1 Organoleptical Test

Organoleptical tests are used to examine the physical appearance of body scrubs using the five senses. The examination includes the shape, color, smell of the preparation [14].

2.8.2 Homogeneity Test

The homogeneity test was carried out by applying a sample of 0.1 gram to the object glass, then observed [15]. The ingredients used in pumpkin juice body scrub (*Curcubita moschata*) and coconut pulp (*Cocos nucifera* L) must be evenly dispersed in the preparation. This test is conducted to see if there are parts that are not well mixed [16].

2.8.3 pH Test

Taken as much as 0.5 grams of cream preparation and diluted with 5 mL of distilled water in a beaker glass, then dipped the pH meter into the solution, waited a while. The value shown by the pH meter is the pH of the preparation. A good pH value in accordance with the pH of the skin is between 4.5-8.0 to avoid irritation for the skin [17].

2.8.4 Spreadability Test

Weighed as much as 1 gram of cream, placed in the center of a glass plate, then placed another glass plate on top of the cream, left for 1 minute. The diameter of the spreading cream was measured. Added 50 grams of additional weight, observed the diameter area formed. Specification of spreadability a good topical preparation that has a spreadability of 5-7 cm in diameter is recorded as a result, this range was selected based on cosmetic product standards, indicating that an appropriate spreadability ensures comfort during application [18].

2.8.5 Emulsion Type of The Preparation

A number of preparations are placed on a glass slide, one drop of methyl blue is added, stirred with a stirring rod, covered with a cover glass and observed under a microscope. If the methyl blue is evenly distributed, the preparation is M/A emulsion type, but if there are only blue spots, the preparation is A/M emulsion type [19].

2.8.6 Irritation Test

Irritation tests are carried out with the aim of preventing side effects on the skin. Testing by conducting an open patch test. This test was carried out on 5 respondents by applying the preparation to the forearm with a certain area (2.5×2.5 cm) until the preparation dried. Observation of the irritation test was carried out at 0, 24, 48, 72 hours. After the preparation is used by observing the skin reaction that arises using 2 observation parameters, namely the level of erythema (redness reaction) and the level of edema (swelling) [18].

2.8.7 Hedonic Test

The hedonic test was carried out by conducting an analysis according to the liking test (aroma, texture, color parameters of the preparation) using 10 panelists who were given samples of body scrub cream preparations. To see the level of respondents' liking for the cream preparation based on each parameter, namely (very favorable), (favorable), (rather favorable), (unfavorable) [20].

2.9 Statistical Analysis

Data analysis was performed using Microsoft Excel 2021. For the sensory evaluation (hedonic test), the results were summarized by calculating the mean scores for each sensory parameter (e.g., texture, color, fragrance) for each formulation. These mean values were presented in bar charts for visual comparison across the different formulations. This allowed for an easy assessment of the preferences for each formulation based on the sensory attributes.

3 Results and Discussion

3.1 Results

3.1.1 Preparation of body scrub

Natural-based body scrubs have gained significant popularity in the global cosmetics market, particularly within the green cosmetics sector, due to their perceived safety and skin benefits. These products harness the power of various natural ingredients, such as phytochemicals, starch, and flour, which offer a range of functional properties, including exfoliation, nourishment, and antioxidant protection. The formulation utilized pumpkin and coconut pulp as the active ingredient. Five kilograms of pumpkin were peeled, cubed, juiced, and then concentrated in a water bath at 40-60°C, yielding 86 grams of pumpkin juice with a 1.75% yield. Separately, 300 grams of washed coconut pulp were squeezed to separate the water and pulp. The pulp was dried in an oven at 40-60°C, then blended and sieved through a 40-mesh sieve, resulting in 90 grams of dried coconut pulp with a 30% yield.

3.1.2 Formulation and Evaluation Body Scrub

Four formulations (F0, F1, F2, and F3) were developed. Formula F0 was a base cream containing no coconut pulp, while F1, F2, and F3 incorporated 5%, 10%, and 15% coconut pulp alongside 20% pumpkin juice, respectively. The creams were prepared using standard emulsification techniques: oil and water phases were separately heated to 70°C, combined in a mortar, and blended until homogenous. The pumpkin juice and coconut pulp were added last, ensuring uniform distribution before transferring the mixture into containers (Figure 1).



Figure 1. Body Scrub Cream Preparation

Organoleptic Properties

All formulations exhibited a semi-solid consistency suitable for body scrubs. F1 showed a pale yellow color, while F2 and F3 displayed a bright yellow shade due to the increased coconut pulp concentration. The aroma, a combination of pumpkin juice's earthy scent and the tropical note of coconut pulp, intensified with higher coconut pulp percentages (Table 1).

Table 2. Organoleptic Observation Results

Formula	Category		
	Form	Color	odor
F0	Semi-solid	Yellow	Pale
F1	Semi-solid	Yellow	Faint
F2	Semi-solid	Yellow	Bright
F3	Semi-solid	Yellow	Bright

Homogeneity Testing

The homogeneity evaluation confirmed that all formulations were uniform, with no visible separation, lumps, or inconsistencies (Table 2). This consistency ensures an even distribution of active ingredients, vital for the product's efficacy.

Table 3. Homogeneity Evaluation of Body Scrub

Formulation	Result
F0	Homogeneous
F1	Homogeneous
F2	Homogeneous
F3	Homogeneous

(F0) Body scrub cream with 20% pumpkin extract (F1) Body scrub cream with 20% pumpkin extract and 5% coconut pulp (F2) Body scrub cream with 20% pumpkin extract and 10% coconut pulp (F3). Body scrub cream with 20% pumpkin extract and 15% coconut pulp.

pH Analysis

The pH of all formulations ranged between 6.1 and 6.2, within the acceptable range of 4.5–8.0 for topical applications (Table 3). This range minimizes the risk of skin irritation and dryness while maintaining product stability.

Table 4. pH Evaluation of the Body Scrub

Replication	pH Test			
	F0	F1	F2	F3
1	6,2	6,2	6,2	6,2
2	6,1	6,1	6,1	6,2
3	6,1	6,1	6,1	6,2
Average	6,1	6,1	6,1	6,2

Spreadability Evaluation

Spreadability, crucial for user comfort and active ingredient distribution, was assessed using petri dish diameters. All formulations met the desired range of 5–7 cm. F0 showed the highest spreadability at 6.1 cm, while F3, containing the highest coconut pulp concentration, had the lowest spreadability (5.5 cm), indicating a thicker consistency (Table 4).

Table 5. Spread Ability Evaluation of The Body Scrub

Replication	Spread ability (cm)			
	F0	F1	F2	F3
1	6.5	6	5,6	5,5
2	6	5,8	5.5	5,5
3	6	5,6	5,7	5,5
Average	6.1	5,8	5,6	5,5

Irritation Test

No irritation or adverse reactions were observed in any formulation during skin testing, confirming their safety for topical use and the result were presented in (Figure 2).

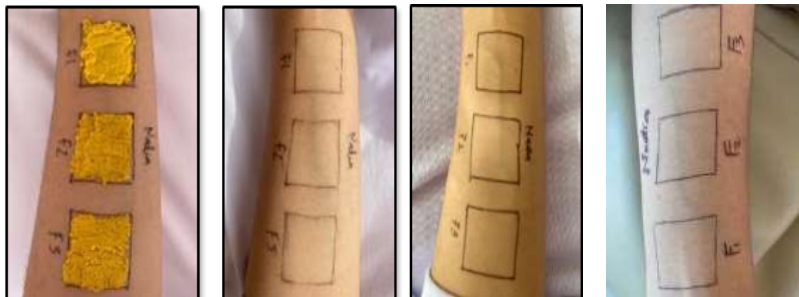


Figure 2. The Irritation Test Results

Hedonic Test

Consumer preference evaluations revealed that F3 was the most favored formulation, appreciated for its vibrant color, appealing aroma, and smooth texture (Figures 3–5 provide a visual summary of the hedonic test results for texture, color, and aroma, respectively).

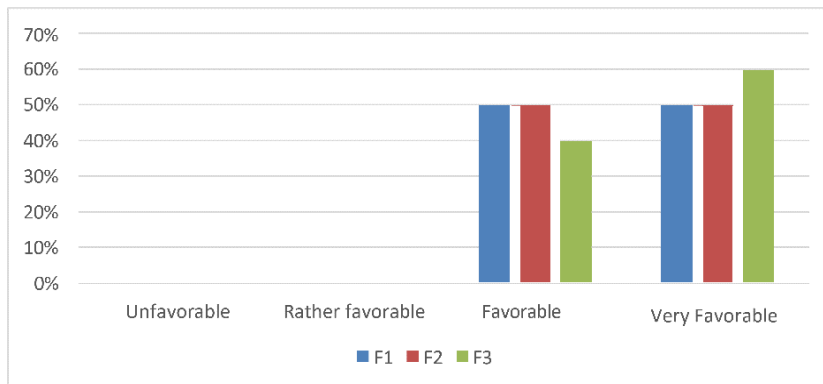


Figure 3. Favorability Test of Body Scrub's Texture

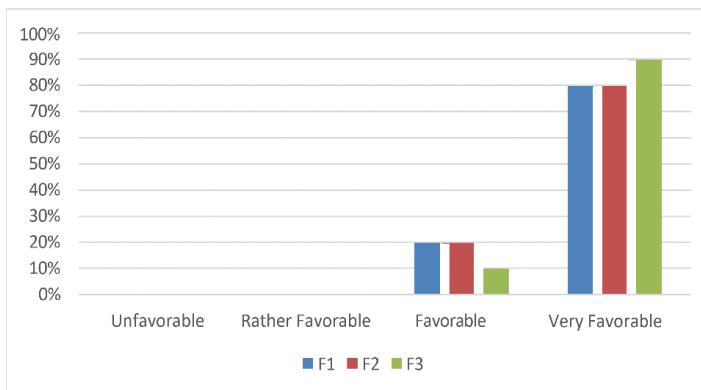


Figure 4. Favorability Test of Body Scrub's Color

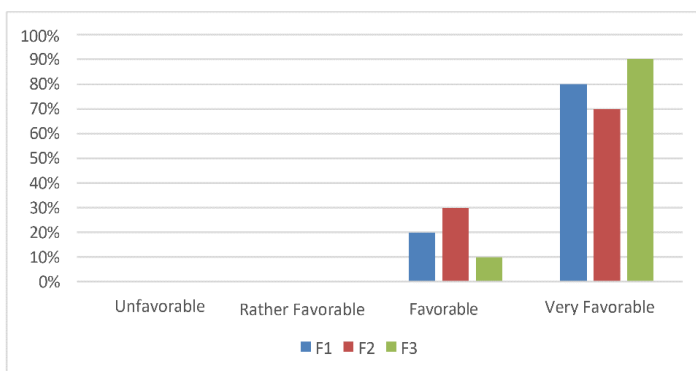


Figure 5. Favorability Test of Body Scrub's Aroma

3.2 Discussion

This study aimed to develop a body scrub cream formulation utilizing yellow pumpkin juice and coconut pulp as primary ingredients. The yellow pumpkin (*Cucurbita pepo*) used in this research was sourced fresh from the Lambaro market in Aceh Besar. A total of 5 kg of pumpkin was processed. The pumpkins were peeled, thoroughly washed under running water, and chopped into small pieces. The pieces were then ground into a pulp, from which the juice was extracted. The extracted pumpkin juice was subsequently dried using a water bath set at a temperature of 40-60°C over 4-6 hours, yielding 86 grams of dried yellow pumpkin juice. This process resulted in a yield of 1.72%, calculated from the initial 5 kg of fresh pumpkin [21].

In addition to yellow pumpkin juice, coconut pulp obtained from the Lambaro market in Aceh Besar was incorporated into the formulation. The coconut pulp was initially dried in an oven to reduce its moisture content, a crucial step to prevent mold growth. After drying, the pulp was sieved using a 40-mesh sieve to ensure uniform particle size for further processing [22]. This sieving process was essential to achieve a uniform particle size, ensuring that the pulp was evenly processed and integrated into the formulation, which contributes to the consistency and quality of the final body scrub cream [23]. The yellow pumpkin juice and coconut pulp were then incorporated into the formulation of a body scrub cream, combining both ingredients in various proportions. Four distinct formulations were developed: F0 contained 20% yellow pumpkin juice and 0% coconut pulp, F1 included 20% yellow

pumpkin juice and 5% coconut pulp, F2 comprised 20% yellow pumpkin juice and 10% coconut pulp, and F3 contained 20% yellow pumpkin juice and 15% coconut pulp. The base of the body scrub cream was composed of two phases: an oil phase, consisting of stearic acid and cetyl alcohol, and a water phase, containing propylene glycol, triethanolamine (TEA), methylparaben, and distilled water. Each ingredient in the vanishing cream-based formulation played a distinct and crucial role: stearic acid formed the oil phase, contributing to the cream's texture and consistency; cetyl alcohol was incorporated to enhance emulsion stability and ensure the cream's structural integrity; propylene glycol served as both a solvent and a humectant, aiding in the dissolution of other components while attracting and retaining moisture; triethanolamine (TEA) functioned as a surfactant, facilitating the formation and maintenance of a stable emulsion; and methylparaben was included as a preservative to inhibit microbial growth and ensure the product's safety and longevity, particularly because the water content in the cream provides a medium for bacterial proliferation [24] [25] [26].

The cream preparation process involved melting the oil phase ingredients in a porcelain dish at 60°C. Simultaneously, the water phase ingredients were dissolved in hot distilled water within the same dish. The melted oil phase was then transferred into a preheated mortar, followed by the gradual addition of the water phase. The mixture was thoroughly ground until a homogeneous cream was formed. Finally, the yellow pumpkin juice and coconut pulp were incorporated, and the mixture was blended with a spatula until a uniform consistency was achieved [27].

The body scrub cream formulations containing yellow pumpkin juice and coconut pulp were subsequently subjected to a series of evaluations, including organoleptic assessment, homogeneity testing, pH measurement, spreadability testing, emulsion type determination, irritation testing, and a hedonic (preference) test. The organoleptic evaluation focused on the color, consistency, and odor of each formulation [14]. Formulation F0 exhibited a pale yellow color, F1 had a faded yellow hue, while F2 and F3 displayed a bright yellow color. All formulations exhibited a semi-solid texture, which is ideal for a body scrub cream, providing the right balance between firmness and ease of application [28]. This texture ensures that the cream is thick enough to provide effective exfoliation while still being smooth and spreadable [29]. The odor profile of each formulation was notably influenced by the natural ingredients used. The scent of yellow pumpkin juice imparted a subtle, earthy aroma, while the coconut pulp added a rich, tropical fragrance. The second test performed was the homogeneity test, which aimed to determine whether any part of the cream was not uniformly mixed [30]. This test is crucial to ensure that all ingredients are evenly mixed and distributed, thereby guaranteeing that the active ingredients in the formulation provide consistent benefits across all areas of the skin upon application [31]. A homogeneous cream is characterised by consistent colour, smooth texture, and even distribution of all components with no visible lumps or separation. In this study, the homogeneity test results for the scrub formulation showed that all samples consistently exhibited uniform colour, smooth consistency, and even distribution of ingredients across multiple batches. These findings confirmed that the scrub cream had a stable and homogeneous structure, highlighting the reproducibility and robustness of the formulation.

The pH test was conducted to evaluate the safety of the body scrub cream, ensuring it would not cause irritation during use. The recorded pH values were 6.1 for F0, F1, and F2, and 6.2 for F3. This range is particularly suitable for skin applications as it aligns with the natural pH of human skin, which typically ranges between 4.5 and 5.5. Maintaining this balance helps protect the skin barrier and prevents irritation or dryness caused by more acidic or alkaline formulations [17]. If the pH of the body scrub dosage form is too acidic, it may cause skin irritation. On the other hand, if the pH is too alkaline, it can result in skin dryness [32]. The pH values are critical to the efficacy of a body scrub, as they significantly affect its physical stability. The pH level influences the behavior of excipients such as Carbopol and

stearic acid, which are sensitive to pH fluctuations [33]. Additionally, the stability of the active ingredients within the emulgel can be impacted by changes in pH, affecting the overall performance and effectiveness of the dosage form [34].

The spreadability test was performed using a petri dish to measure the diameter of the spread achieved by the body scrub cream. This evaluation was essential to determine the cream's efficiency in spreading over the skin when applied. Spreadability is a key attribute of topical formulations, as it directly affects how evenly the product covers the skin's surface [35]. A cream with optimal spreadability ensures that its active ingredients are distributed more uniformly across a larger area, which can enhance its overall effectiveness and user experience [6]. In this study, the spreadability of the body scrub cream was assessed by applying the cream to a petri dish and measuring the diameter of the spread. The ideal spreadability for topical formulations is generally considered to fall within the range of 5 to 7 cm [36]. The results from this study showed that all formulations met these standards, with spread diameters of 6.1 cm for F0, 5.8 cm for F1, 5.6 cm for F2, and 5.5 cm for F3. These findings indicate that each formulation possessed adequate spreadability, effectively aligning with the desired criteria for optimal performance in topical applications. The results highlight that the cream's ability to spread across the skin surface is within acceptable limits, ensuring that users can apply the product easily and achieve uniform coverage [37].

The emulsion type test was conducted to confirm whether the emulsion type of the body scrub cream matched the intended formulation. Various methods can be used to determine emulsion type, including phase dilution, dyeing, creaming, electrical conductivity, fluorescence, and filter paper techniques. In this study, the dyeing method using methylene blue was employed. Methylene blue, a water-soluble blue dye, helps differentiate between oil and water phases in the emulsion [38]. When added to the cream, the dye colors the water phase blue, while the oil phase remains colorless. If the dye is evenly distributed throughout the cream, the formulation is classified as an oil-in-water (O/W) emulsion, as the dye dissolves in the water phase. Conversely, if only blue spots are visible, the formulation is a water-in-oil (W/O) emulsion. In this study, the dyeing method indicated that the body scrub cream was an oil-in-water (O/W) emulsion, with water as the external phase. This emulsion type is advantageous as it spreads easily on the skin, is non-sticky, and can be readily washed off with water [19].

The irritation test was conducted to evaluate whether the ingredients used in the body scrub cream formulation could cause skin irritation [39]. This test is essential in evaluating the safety of topical products, as it ensures that the formulations do not cause adverse reactions when applied to the skin. The formulations were applied into F1, F2, and F3 to a 2.5 cm x 2.5 cm area on the lower forearm of five respondents. The test areas were observed at intervals of 0, 24, 48, and 72 hours post-application. The presence and severity of edema and erythema were assessed using a scoring system, and the irritation index was subsequently calculated [40]. The detailed edema and erythema index values are presented in (Figure 2). The lower forearm was selected as the test site for the irritation test because its skin exhibits sensitivity similar to that of facial skin. Moreover, the minimal presence of fine hair on the lower forearm allows for easier observation of any potential signs of irritation [41]. The results of the irritation test revealed no skin reactions among any of the respondents, indicating that the body scrub cream formulation containing yellow pumpkin juice and coconut pulp is safe for use and does not cause skin irritation. However, while the irritation test confirmed the formulation's short-term safety, it is important to consider potential long-term skin compatibility issues that result from natural ingredient products [42].

A hedonic test was conducted to evaluate respondents' preferences for a body scrub cream formulated with a combination of yellow pumpkin juice and coconut pulp. The test involved ten respondents, who were asked to rate the color, texture, and aroma of three different formulations (F1, F2, and F3) using a standardized questionnaire. Formulation F3, which

contained 20% yellow pumpkin juice and 15% coconut pulp, emerged as the most favored option across all sensory attributes. Specifically, 6 out of 10 respondents (60%) preferred the texture of F3, citing its smoothness and ease of application, while an overwhelming 9 respondents (90%) expressed a strong preference for its color and aroma. The data suggest that the higher concentration of coconut pulp in F3 contributed to a more pronounced coconut scent, which was a key factor in its preference rating. Although formulations F1 and F2 also received some positive feedback, F3 consistently achieved the highest overall scores, indicating that the combination of these natural ingredients in specific proportions significantly enhances consumer appeal [43]. The sensory characteristics of F3, particularly its texture and fragrance, were significantly influenced by the concentration of coconut pulp. The increased pulp content likely contributed to the formulation's creaminess and rich scent, aligning with consumer preferences for sensory satisfaction in body scrubs. However, F3's higher concentration of coconut pulp consistently achieved the highest sensory scores. Future improvements to formulations with lower pulp content could focus on enhancing texture and aroma through the careful adjustment of other ingredients or optimizing the coconut pulp concentration to balance sensory appeal with product performance.

4 Conclusion

This study successfully developed body scrub formulations combining pumpkin juice (*Curcubita moschata*) and coconut pulp (*Cocos nucifera* L). The formulations, with varying coconut pulp concentrations (5%, 10%, and 15%), exhibited good stability, skin compatibility, and desirable physical properties, including uniform texture and color. They met the required pH levels (6.1 to 6.2) and demonstrated adequate spreadability (5.5 to 6.1 cm). Irritation tests confirmed no adverse skin reactions, indicating safety for use. The hedonic test revealed that the F3 formulation (15% coconut pulp) was preferred for its superior color, aroma, and overall comfort, suggesting that higher coconut pulp concentrations enhance sensory qualities and effectiveness. These findings highlight the potential of natural ingredients like pumpkin juice and coconut pulp for creating safe, effective, and appealing body scrubs with antioxidant benefits and exfoliation properties. However, the use of higher concentrations of pumpkin juice and coconut pulp in formulations may lead to instability and increased susceptibility to microbial contamination. To mitigate these risks, methylparaben was incorporated as a preservative to ensure product stability and safety.

References

1. P. Załęcki, K. Rogowska, P. Waś, K. Łuczak, M. Wysocka, D. Nowicka, Impact of lifestyle on differences in skin hydration of selected body areas in young women. *Cosmetics* **11**, 13 (2024)
2. Q. Jiao, L. Zhi, B. You, G. Wang, N. Wu, Y. Jia, Skin homeostasis: Mechanism and influencing factors. *J. Cosmet. Dermatol.* **23**, 1518–1526 (2024)
3. N.H. Irmazida, E.R. Apriliana, N.F.A. Zuhrah, A. Febriarta, P. Wahyuni, A. Quraini, Self-attitude towards skin health in adolescents. *Pharmacol. Med. Rep. Orthop. Illn. DETAILS COMORBID* (2023)
4. Z.D. Draelos, *Cosmeceuticals: Procedures in cosmetic dermatology Series* (Elsevier Health Sciences, 2024)
5. P. Chaudhary, P. Janmeda, A.O. Docea, B. Yeskaliyeva, A.F. Abdull Razis, B. Modu, et al., Oxidative stress, free radicals and antioxidants: Potential crosstalk in the pathophysiology of human diseases. *Front. Chem.* **11**, 1158198 (2023)

6. A. Simoes, F. Veiga, C. Vitorino, Developing cream formulations : Renewed interest in an old problem. *J. Pharm. Sci.* **108**, 3240–3251 (2019)
7. E. Rostkowska, E. Poleszak, K. Wojciechowska, K. Dos Santos Szewczyk, Dermatological management of aged skin. *Cosmetics* **10**, 55 (2023)
8. P. Pavlou, A. Siamidi, A. Varvaressou, M. Vlachou, Skin care formulations and lipid carriers as skin moisturizing agents. *Cosmetics* **8**, 89 (2021)
9. H.T. Hoang, J.Y. Moon, Y.C. Lee, Natural antioxidants from plant extracts in skincare cosmetics: Recent applications, challenges and perspectives. *Cosmetics* **8**, 106 (2021)
10. B. Salehi, C. Quispe, J. Sharifi-Rad, L. Giri, R. Sual, A.K. Jugran, et al., Antioxidant potential of family Cucurbitaceae with special emphasis on Cucurbita genus: A key to alleviate oxidative stress-mediated disorders. *Phytother. Res.* **35**, 3533–3557 (2021)
11. P.S. Beegum, J.P. Nair, M. Manikantan, R. Pandiselvam, S. Shill, S. Neenu, et al., Effect of coconut milk, tender coconut and coconut sugar on the physico-chemical and sensory attributes in ice cream. *J. Food Sci. Technol.* 1–12 (2022)
12. S. Bom, J. Jorge, H.M. Ribeiro, J. Marto, A step forward on sustainability in the cosmetics industry: A review. *J. Clean. Prod.* **225**, 270 (2019)
13. K. Fitri, T.N. Khairani, K.T. Sianturi, L. Leny, I. Hafiz, Anti-inflammatory activity of ethanol extract of lotus (*Nelumbo nucifera* G.) seed against white male rats using paw edema method. *J. Drug Deliv. Ther.* **11**, 1–4 (2021)
14. M. Jamilatun, H.A. Rahmadianty, P.I. Lukito, Quality analysis of cream scrub combination of Moringa (*Moringa oleifera*) leaf extract and white glutinous rice (*Oryza sativa glutinosa*) starch. *Int. J. Multidiscip. Approach Res. Sci.* **1** (2023)
15. D. Rachmawati, H. Salim, D. Karim, Formulasi sediaan lulur krim yang mengandung tepung jintan hitam (*nigella sativa* l.) dengan variasi konsentrasi trietanolamin. *Media Farm.* **16**, 18 (2021)
16. L. Leny, V.E. Diana, M. Ginting, B. Iskandar, C. Fadhila, The effectiveness of pandan wangi leaves (*Pandanus amaryllifolius* Roxb.) body scrub formulation in smoothing the skin. *Asian J. Pharm. Res. Dev.* **10**, 1–5 (2022)
17. M. Lukić, I. Pantelić, S.D. Savić, Towards optimal pH of the skin and topical formulations : From the current state of the art to tailored products. *Cosmetics* **8**, 69 (2021)
18. F. Grace, B. Anbarasan, T. Kanimozhi, S. Shanmuganathan, Preparation and evaluation of deep cleansing exfoliator. *Asian J. Pharm. Clin. Res.* **11**, 7, 356–359 (2018).
19. I.K. Dewi, T. Lestari, S.N. Rofi'ah, Formulation and physical test of ethanolic extract Sambiloto leaves (*Andrographis paniculata*) ointment. *Sains Med.* **6**, 56–60 (2016)
20. N.A. Ahmi, S.F. Sabran, Formulation and evaluation of body scrub using pineapple waste as natural exfoliator. *Malays. J. Anal. Sci.* **28**, 603–610 (2024)
21. A.O. Barel, M. Paye, H.I. Maibach (eds.), *Handbook of Cosmetic Science and Technology* (CRC Press, Boca Raton, 2014)
22. A. Kumar (ed.), *Coconut: Production and Processing Technology* (Asia Pacific Business Press, New Delhi, 2010)
23. P. Bakker, H. Woerdenbag, V. Gooskens, B. Naafs, R. van der Kaaij, N. Wieringa, *Dermatological preparations for the tropics* (2012)
24. H. Dao, P. Lakhani, A. Police, V. Kallakunta, S.S. Ajjarapu, K.W. Wu, et al., Microbial stability of pharmaceutical and cosmetic products. *AAPS PharmSciTech* **19**, 60–78 (2018)
25. M.F. Uddin, M.K. Ullah, M.A. Ahmed, S. Samreen, H. Habeeb, Preparation and evaluation of polyherbal vanishing cream of ethanolic extract of crude drugs. *Int. J. Appl. Pharm. Sci. Res.* (2019)
26. N. Zhang, L. Wang, X. Deng, R. Liang, M. Su, C. He, et al., Recent advances in the detection of respiratory virus infection in humans. *J. Med. Virol.* **92**, 408–417 (2020)

27. L.V. Allen, N.G. Popovich, H.C. Ansel, *Ansel's Pharmaceutical dosage forms and drug delivery systems* (Lippincott Williams & Wilkins, Philadelphia, 2011)
28. G. Savary, M. Grisel, C. Picard, *Cosmetics and personal care products*. In *Nat. Polym. Ind. Tech. Appl.*, 219–261 (2016)
29. M. Kumar, U.K. Mandal, S. Mahmood, *Dermatological formulations. In dosage forms, formulation developments and regulations* (Elsevier, 2024), 613–642
30. M. Yu, C. Zheng, T. Li, H.L. Song, L. Wang, W. Zhang, et al., *Comparison of aroma properties of infant formulas*. *J. Dairy Sci.* (2023)
31. N. Lumentut, H.J. Edi, E.M. Rumondor, *Formulasi dan uji stabilitas fisik sediaan krim ekstrak etanol kulit buah pisang Goroho (Musa acuminata L.) konsentrasi 12.5% sebagai tabir surya*. *J. MIPA* **9**, 2, 42 (2020).
32. K.A. Adrianta, P.E. Yuda, P.S. Purnamasari, N.M.D. Suen, *Jackfruit (artocarpus heterophyllus lamk) leaf as a natural sun stick protector through the inhibition of the MMP-1 receptor*. *Trop. J. Nat. Prod. Res.* **7**, 5, 2952–2958 (2023).
33. P.J. Sheskey, W.G. Cook, C.G. Cable, *Handbook of pharmaceutical excipients* (2017).
34. S. Vázquez-Blanco, L. González-Freire, M.C. Dávila-Pousa, C. Crespo-Diz, *pH determination as a quality standard for the elaboration of oral liquid compounding formula*. *Farm. Hosp.* **42**, 6, 221–227 (2018).
35. T. Alves, D. Arranca, A. Martins, H. Ribeiro, S. Raposo, J. Marto, *Complying with the guideline for quality and equivalence for topical semisolid products: The case of clotrimazole cream*. *Pharmaceutics* **13**, 4, 555 (2021).
36. D. Saryanti, I.N. Zulfa, *Optimization carbopol and glycerol as basis of hand gel antiseptics extract ethanol ceremai leaf (Phyllanthus acidus (L.) Skeels) with simplex lattice design*. *JPSCR J. Pharm. Sci. Clin. Res.* **2**, 1, 35–43 (2017).
37. N.K. Okoro, B.A. Oseni, O.O. Okubanjo, A.A. Adegun, M.O. Ilomuanya, *Development of Diclofenac and Capsaicin Emulgel for the Management of Inflammation in Rheumatoid Arthritis*. *Trop. J. Nat. Prod. Res.* **7**, 6 (2023).
38. R. Voight, *Buku Pelajaran Teknologi Farmasi* (Gadjah Mada Universitas Press, Yogyakarta, 1995).
39. M.N. Rivero et al., *Comparison between HET-CAM protocols and a product use clinical study for eye irritation evaluation of personal care products including cosmetics according to their surfactant composition*. *Food Chem. Toxicol.* **153**, 112229 (2021).
40. C.T. Olson, *Evaluation of the dermal irritancy of chemicals*, in *Dermal and Ocular Toxicology* (CRC Press, 2020)
41. D.V. Belsito, J. Goodman, (eds.), *Safety assessment of cosmetic ingredients* (CRC Press, Boca Raton, 2017).
42. N.M. Suen, L.R. Rahayu, S.C. Wijaya, N.P. Antari, K.A. Adrianta, *Formulation and antioxidant activity test of Centella asiatica herba extract and Moringa oleifera leaves extract as an anti-aging emulgel*. *Trop. J. Nat. Prod. Res.* **8**, 3, 6525–6536 (2024).
43. V.H. Junior, A.L. Mendes, C.C. Talhari, H.A. Miot, *Impact of environmental changes on Dermatology*, *An Bras Dermatol*, **96**, 2, 210–223 (2021)