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Effect of Spent Coffee Grounds on the Organoleptic Properties, pH, Moisturizing Effect, and Skin Irritation of Body Scrub Formulated with Waste Cooking-Olive Oils Liquid Soap

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Abstract. Spent coffee grounds (SCG) have potential as a sustainable exfoliating material for body scrub formulations. This study evaluated the effects of systematically varying the proportions of SCG and liquid soap derived from waste cooking oil and olive oil on the organoleptic properties, pH, moisturizing effect, and skin irritation responses of body scrubs. Three formulations containing 3% cornstarch were prepared with SCG and liquid soap proportions of 40:57% (V1), 50:47% (V2), and 60:37% (V3), respectively. Organoleptic properties were evaluated descriptively, pH was measured in triplicate, and moisturizing and irritation responses were assessed observationally in 13 respondents. Increasing SCG progressively changed the texture from smooth (V1) to moderately coarse (V2) and coarse (V3), while all formulations exhibited a coffee odor and black color. The pH values were 7.87 ± 0.23, 7.70 ± 0.07, and 7.38 ± 0.38 for V1, V2, and V3, respectively, all within the pH range of 4.5–8.0 adopted according to SNI 16-4399-1996, with no significant differences among formulations [one-way ANOVA, $F(2,6) = 2.781$, $p = 0.140$]. Positive moisturizing responses were observed in all respondents for V1 and V2 (13/13; 100%), but not for V3 (0/13; 0%). No itching, erythema, or edema was observed for any formulation during the 30-min observation period. Overall, V1 exhibited the most favorable combination of characteristics among the formulations evaluated. These findings indicate that the SCG–liquid soap compositional balance is an important formulation factor influencing the physicochemical and observed skin-response characteristics of SCG-based body scrubs.

Keywords: *Body scrub, spent coffee grounds, liquid soap, moisturizing effect, skin irritation*

Abstrak. Ampas minuman kopi (*spent coffee grounds*, SCG) berpotensi sebagai bahan eksfoliasi berkelanjutan dalam formulasi body scrub. Penelitian ini mengevaluasi pengaruh variasi sistematis proporsi SCG dan sabun cair berbasis minyak jelantah dan minyak zaitun terhadap sifat organoleptik, pH, efek pelembapan, dan respons iritasi kulit *body scrub*. Tiga formulasi yang mengandung 3% tepung maizena dibuat dengan proporsi SCG dan sabun cair masing-masing sebesar 40:57% (V1), 50:47% (V2), dan 60:37% (V3). Sifat organoleptik dievaluasi secara deskriptif, pH diukur dalam tiga kali pengulangan, sedangkan efek pelembapan dan respons iritasi dievaluasi secara observasional pada 13 responden. Peningkatan SCG secara bertahap mengubah tekstur dari halus (V1) menjadi agak kasar (V2) dan kasar (V3), sementara seluruh formulasi menunjukkan aroma kopi dan warna hitam. Nilai pH V1, V2, dan V3 masing-masing sebesar 7,87 ± 0,23; 7,70 ± 0,07; dan 7,38 ± 0,38, yang seluruhnya berada dalam rentang pH 4,5–8,0 yang diacu berdasarkan SNI 16-4399-1996, tanpa perbedaan yang signifikan antarformulasi [one-way ANOVA, $F(2,6) = 2{,}781$; $p = 0{,}140$]. Respons pelembapan positif teramati pada seluruh responden untuk V1 dan V2 (13/13; 100%), tetapi tidak pada V3 (0/13; 0%). Tidak ditemukan gatal, eritema, maupun edema pada seluruh formulasi selama periode observasi 30 menit. Secara keseluruhan, V1 menunjukkan kombinasi karakteristik paling baik di antara formulasi yang dievaluasi. Temuan ini menunjukkan bahwa keseimbangan komposisi SCG–sabun cair merupakan faktor formulasi penting yang memengaruhi karakteristik fisikokimia dan respons kulit yang teramati pada *body scrub* berbasis SCG.

Kata kunci: *Body scrub, ampas minuman kopi, sabun cair, efek pelembapan, iritasi kulit*

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INTRODUCTION

The skin is the outermost layer of the human body and serves as a primary barrier between internal tissues and the external environment (Bakhri et al., 2022; Kalangi, 2013; Sari & Anggraeny, 2021). Daily exposure to sunlight and environmental pollutants may contribute to skin dullness, dryness, and moisture loss (Rajkumar et al., 2023). Appropriate skin care is therefore important for maintaining skin cleanliness, moisture, and overall condition (Ningsih et al., 2023). Body scrubs are among the cosmetic products used for this purpose, particularly because they assist in cleansing the skin surface and removing dead skin cells.

Body scrubs are cosmetic products containing exfoliating materials that help smooth the skin, remove dead skin cells and impurities, and cleanse clogged pores (Hairiyah et al., 2022; Musdalipah, 2016). Their use may also contribute to maintaining skin moisture and appearance (Mel, 2023). The performance of a body scrub formulation is influenced by the characteristics of both the exfoliating material and its carrier medium. In the context of utilizing natural and waste-derived materials, SCG have potential as an exfoliating material because of their particulate characteristics and the presence of bioactive compounds, including flavonoids, polyphenols, chlorogenic acid, and dicaffeoylquinic acid (Mel, 2023). In addition to their exfoliating function, incorporating SCG into cosmetic formulations provides an opportunity to add value to residues generated from coffee consumption (Andarwati, 2023). Recent research has also demonstrated the feasibility of incorporating SCG at different concentrations into cosmetic exfoliant bases, although formulation characteristics and skin responses depend on the carrier system employed.

Various natural materials have been investigated as functional or exfoliating ingredients in body scrub formulations, including black glutinous rice and honey (Hairiyah & Nuryati, 2020), guava leaf extract (Sari & Anggraeny, 2021), purple sweet potato (Musdalipah, 2016), Moringa oleifera and Oryza sativa (Dira & Dewi, 2022), ethanolic extracts of cassava leaves (Malik et al., 2020), and coffee grounds (Dasawanti & Dhiba, 2024). More recently, SCG have been specifically investigated as natural exfoliating particles in cosmetic formulations, demonstrating their potential for incorporation at different concentrations while also supporting the valorization of coffee-derived residues (Elezović et al., 2025). SCG have also been incorporated into body scrub formulations with other natural materials. In particular, (Bakhri et al., 2024) developed a coffee-ground-based scrub containing waste cooking oil, olive oil, castor oil, and other components. Thus, the use of SCG as a body scrub ingredient is not, by itself, an entirely novel concept. Rather, these previous findings provide a basis for more specifically evaluating how variations in SCG content and the carrier medium influence the resulting formulation characteristics.

In addition to SCG, waste cooking oil has potential for valorization as a soap raw material through saponification, thereby adding value to household oil residues. The utilization of waste cooking oil for soap production has been investigated in various formulation systems, with product characteristics influenced by factors such as processing conditions and alkali concentration. Combinations of waste cooking oil and olive oil have also previously been utilized to produce hand soap. Mapparessa et al. (2023) evaluated hand soap derived from waste cooking oil and olive oil in terms of antimicrobial activity, moisturization, irritation, and foam height (Mapparessa et al., 2023), whereas *Bakhri et al. (2023)* developed hand soap based on these oils with emphasis on antibacterial and skin-moisturizing properties (Bakhri et al., 2023). These studies demonstrate the potential of waste cooking oil and olive oil as soap raw materials; however, the use of liquid soap derived from these oils as a carrier medium in body scrub formulations containing different proportions of SCG warrants further evaluation.

Against this background, the contribution of the present study does not rely solely on the use of SCG as an exfoliating material, but rather on evaluating a formulation system that combines SCG with liquid soap produced from waste cooking oil and olive oil. Based on the literature considered in this study, the effect of systematically varying the proportion of SCG relative to waste cooking oil–olive oil-based liquid soap on body scrub characteristics has not been sufficiently evaluated. In particular, further investigation is needed to determine how increasing the proportion of SCG while decreasing the proportion of liquid soap affects organoleptic properties, pH, moisturizing effects, and skin irritation responses. To address this gap, three formulations containing SCG and liquid soap at proportions of 40:57% (V1), 50:47% (V2), and 60:37% (V3), respectively, were evaluated while maintaining the cornstarch content at 3%. This formulation design enables systematic evaluation of the relationship between compositional variation and the resulting body scrub characteristics.

Accordingly, this study aimed to evaluate the effect of varying the proportion of SCG on the organoleptic properties, pH, moisturizing effects, and skin irritation responses of body scrub formulations prepared with liquid soap derived from waste cooking oil and olive oil. The formulation variations were further evaluated to identify the formulation exhibiting the most favorable combination of characteristics among those investigated.

MATERIALS AND METHODS

Materials

The materials utilized in this study comprised pure spent coffee grounds (without milk or sugar) collected from coffee shops within the Universitas Muslim Indonesia campus, cornstarch, waste cooking oil (sourced from used household palm cooking oil), olive oil (Herborist®), potassium hydroxide (KOH), citric acid, and distilled water. Spent coffee grounds functioned as the exfoliating agent in the body scrub formulations, while waste cooking oil and olive oil served as the primary raw materials for liquid soap production. The equipment employed included a hot plate, beakers, a glass stirring rod, an analytical balance, a cooking pot, a spatula, a thermometer, a cooling container, and a pH meter. These instruments facilitated the preparation of liquid soap, formulation of the body scrub, and evaluation of the final products.

Research Design

This study employed an experimental design consisting of two stages: liquid soap preparation and body scrub formulation. In the first stage, two liquid soap formulations (F1 and F2) were prepared by maintaining the amounts of waste cooking oil and olive oil constant while varying the amount of potassium hydroxide

(KOH). F1 contained 50 g of KOH, whereas F2 contained 100 g of KOH. The resulting liquid soap formulations were evaluated for organoleptic characteristics and pH with reference to the quality requirements specified in SNI 06-4085-1996. The composition of the liquid soap formulations is presented in Table 1.

Table 1. Composition of the liquid soap formulations.

Raw Materials	Formulations (g)	
	F1	F2
Independent Variable		
KOH	50	100
Controlled Variables		
Waste Cooking Oil	125	125
Olive Oil	125	125

Three body scrub formulations were developed by systematically varying the relative proportions of SCG and F1 liquid soap while maintaining the cornstarch content at 3%. As shown in Table 2, the SCG content increased from 40% in V1 to 50% in V2 and 60% in V3, accompanied by a corresponding decrease in liquid soap from 57% to 47% and 37%, respectively. Thus, the experimental design evaluated the effect of the SCG–liquid soap compositional balance on the properties of the resulting body scrub formulations.

Table 2. Composition of raw materials used in body scrub formulations (based on a 100 g formulation)

Raw Materials	Composition of Raw Materials (%)		
	V1	V2	V3
Controlled Variables			
Cornstarch	3	3	3
Varied Formulation Components			
Liquid Soap	57	47	37
Spent Coffee Grounds	40	50	60

Procedure

Preparation of liquid soap

Waste cooking oil (125 g) and olive oil (125 g) were mixed and heated to 70ºC, and this temperature was maintained during the saponification process. KOH (50 g for F1 and 100 g for F2) was prepared as an alkaline solution and gradually added to the oil mixture under continuous stirring until a homogeneous and viscous soap paste was formed. The mixture was maintained at 70ºC for 3 h with continuous stirring. After formation of the soap paste, 500 g of boiled distilled water was added to dilute and dissolve the paste. Subsequently, a citric acid solution prepared by dissolving 3 g of citric acid in 28 g of distilled water was gradually added under continuous stirring until the mixture was homogeneous. The resulting liquid soap was stored for two weeks before further evaluation to improve clarity and stability (Mapparessa et al., 2023).

Organoleptic properties and pH evaluation of liquid soap

The organoleptic properties of the liquid soap formulations (F1 and F2) were evaluated descriptively based on texture, odor, and color. The evaluation criteria were referenced to SNI 06-4085-1996, which specifies the organoleptic quality characteristics of liquid soap (Dimpudus et al., 2017). The pH of each formulation was measured using a Lutron PH-201 pH meter. The measured pH values were compared with the pH range of 9–11 specified for liquid soap according to SNI 06-4085-1996 (Mapparessa et al., 2023).

Preparation of body scrub

The ingredients for each body scrub formulation were weighed according to the compositions presented in Table 2, with a total mass of 100 g per formulation. Liquid soap and cornstarch were first combined and mixed until homogeneous. SCG were then gradually incorporated into the mixture under continuous mixing to promote uniform distribution of the exfoliating particles throughout the liquid soap phase. The prepared formulations were transferred into separate containers and allowed to stand for 24 h before subsequent evaluation.

Organoleptic evaluation

The organoleptic characteristics of the body scrub formulations (V1, V2, and V3) were evaluated descriptively based on texture, odor, and color, with reference to the sensory evaluation principles of SNI 01-2346-2006. Observations were conducted over a 14-day period to identify changes in the organoleptic characteristics of the formulations during short-term storage. Texture was assessed descriptively and classified as smooth, moderately coarse, or coarse based on the observable characteristics of each formulation. Odor was evaluated according to the characteristic aroma detected in the formulations, while color was determined by visual observation. The organoleptic characteristics of V1, V2, and V3 were recorded and compared descriptively to evaluate changes associated with the different proportions of SCG and liquid soap in the formulations. Because the organoleptic evaluation generated descriptive categorical observations rather than continuous quantitative measurements, the results were presented descriptively without inferential statistical analysis.

pH Evaluation

The pH of each body scrub formulation (V1, V2, and V3) was measured in triplicate (n = 3) using a Lutron PH-201 pH meter (Mapparessa et al., 2023). For each measurement, 1 g of the body scrub sample was dispersed in 100 mL of distilled water prior to pH determination. The pH values were recorded and expressed as mean ± standard deviation (SD). The measured values were compared with the pH range of 4.5–8.0 adopted in this study according to SNI 16-4399-1996 (Hairiyah et al., 2022). Statistical analysis of the pH data is described in the Statistical Analysis subsection.

Moisturizing and irritation evaluation

Moisturizing and irritation evaluations were conducted after approval was obtained from the university ethics committee, the Institute for Research and Human Resource Development (LP2S), Universitas Muslim Indonesia. Participation was voluntary, and written informed consent was obtained from all respondents prior to testing. Thirteen undergraduate students from the Chemical Engineering Study Program, Faculty of Industrial Technology, Universitas Muslim Indonesia, voluntarily participated in the evaluation.

Each body scrub formulation (V1, V2, and V3) was applied to the lower forearm of each respondent and subsequently rinsed off. Skin responses were then observed for 30 min using observation-based assessment and questionnaires. The evaluated parameters included itching (It), erythema or redness (Er), edema or swelling (Ed), and moisturization (Mo). For each parameter, an observed reaction or change was recorded as positive (+), whereas the absence of an observable reaction or change was recorded as negative (-). The results were summarized as the number and percentage of respondents exhibiting positive or negative responses for each formulation.

Statistical Analysis

The pH data obtained from the body scrub formulations were expressed as mean ± standard deviation (SD) from three replicate measurements (n = 3). Differences in pH among V1, V2, and V3 were analyzed using one-way analysis of variance (ANOVA), followed by Tukey's honestly significant difference (HSD) post hoc test for pairwise comparisons. Statistical significance was evaluated at $p < 0.05$. Organoleptic data and moisturizing and irritation responses were analyzed descriptively because these data were categorical.

RESULTS AND DISCUSSION

Organoleptic Quality and pH of Liquid Soap

The organoleptic properties and pH values of the prepared liquid soap formulations are presented in Figure 1 and Table 3.

Fig 1. Liquid Soap Formulations

Table 3. Organoleptic properties and pH of the liquid soap formulations and negative control.

Formulations	Texture	Aroma	Color	pH
F1	Liquid	Olive Aroma	Dark Brown	9.5
F2	Liquid	Olive Aroma	Dark Brown	11.9
Waste Cooking Oil (K-)	Liquid	Cooking Oil Aroma	Dark Brown	5.63

Notes :
F = Liquid Soap Formulation; K - = Negative Control

Table 3 shows the organoleptic characteristics and pH values of the liquid soap formulations. Both F1 and F2 exhibited similar organoleptic characteristics, with a dark brown color, an olive oil aroma, and a liquid texture. These results indicate that increasing the amount of KOH from 50 g in F1 to 100 g in F2 did not produce observable differences in the evaluated organoleptic characteristics. In contrast, a clear difference was observed in pH. F1, prepared with 50 g of KOH, exhibited a pH of 9.5, whereas F2, prepared with 100 g of KOH, exhibited a substantially higher pH of 11.9. Since the amounts of waste cooking oil and olive oil were maintained at 125 g each in both formulations, the difference in pH was associated with the variation in the amount of KOH used in the liquid soap formulation.

The higher pH of F2 is consistent with the greater amount of KOH used during saponification. KOH is a strong alkaline reagent required for the conversion of triglycerides into soap; therefore, increasing its amount relative to a constant oil composition can increase the alkalinity of the resulting formulation, particularly when the amount exceeds that required for the available saponifiable material. However, because residual free alkali and the extent of saponification were not directly determined in this study, the higher pH of F2 cannot be attributed quantitatively to unreacted KOH. Based on the pH range of 9–11 specified for liquid soap in SNI 06-4085-1996, F1 was within the specified range, whereas F2 exceeded the upper limit. Therefore, F1 was selected as the liquid soap base for the subsequent body scrub formulations. Accordingly, F2 would not meet the adopted pH criterion for direct use as a liquid soap without further formulation adjustment. Its relatively high alkalinity may also increase the potential for skin discomfort or disruption of the physiological skin barrier, particularly under repeated or prolonged exposure.

The higher pH of F2 was consistent with the greater amount of KOH used in the formulation. KOH acts as a strong alkali during the saponification reaction, and increasing its amount or concentration can increase the alkalinity of the resulting soap. A similar trend has been reported for liquid soap produced from waste cooking oil, in which KOH concentration was identified as one of the factors influencing pH and free alkali content (Hartini et al., 2021). Furthermore, (Silsia et al., 2017) directly reported that increasing the KOH concentration from 25% to 35% increased both the pH and free alkali content of liquid soap produced from used cooking oil.

Organoleptic Evaluation of Body Scrub

The appearance of the prepared body scrub formulations is shown in Figure 2, while their organoleptic characteristics are summarized in Table 4. All formulations exhibited a characteristic coffee odor and black color, indicating that these attributes remained consistent despite variations in the proportions of spent coffee grounds (SCG) and liquid soap. In contrast, a distinct change was observed in texture. V1, containing 40% SCG and 57% liquid soap, exhibited a smooth texture, whereas V2, containing 50% SCG and 47% liquid soap, exhibited a moderately coarse texture. A further increase in SCG content to 60%, accompanied by a decrease in liquid soap content to 37% in V3, resulted in a coarse texture.

Fig 2. Appearance of the prepared body scrub formulations

Table 4. Results of organoleptic evaluation of body scrub formulations

Body Scrub Variant	Texture	Odor	Color
V1	Smooth	Coffee	Black
V2	Moderately coarse	Coffee	Black
V3	Coarse	Coffee	Black

The progressive change in texture from smooth in V1 to moderately coarse in V2 and coarse in V3 indicates that the SCG-to-liquid soap ratio played an important role in determining the textural characteristics of the formulations. Increasing the SCG content from 40% to 60% increased the proportion of solid exfoliating particles within the formulation, while the liquid soap content serving as the carrier phase simultaneously decreased from 57% to 37%. This compositional shift increased the predominance of the particulate character of SCG, resulting in progressively coarser textures. Conversely, the higher liquid soap content in V1 provided a greater proportion of carrier phase relative to the amount of SCG, resulting in a smoother macroscopic texture. Therefore, the observed textural transition was associated not only with increasing SCG content but also with the changing balance between solid exfoliating particles and the liquid carrier phase.

This interpretation is consistent with (Elezović et al., 2025), who developed SCG-based exfoliant products by incorporating SCG at different concentrations into various formulation bases. Their findings demonstrated that SCG content and the characteristics of the formulation base influenced the sensory properties and consumer preferences of the exfoliant products. The formulations exhibiting the most favorable sensory characteristics depended on the combination of SCG concentration and carrier system. These findings support the present results, indicating that the organoleptic characteristics of SCG-based body scrub formulations, particularly texture, are governed by the balance between the particulate SCG fraction and the formulation carrier phase.

Among the three formulations, V1 exhibited the most favorable organoleptic characteristics, particularly its smooth texture, while retaining the characteristic coffee odor and black color also observed in V2 and V3. However, the coarser textures of V2 and V3 should not necessarily be interpreted as formulation failure; rather, they reflect the increased proportion of exfoliating material and the reduced liquid carrier phase. Therefore, within the formulation range investigated, V1 provided the most balanced organoleptic profile between the presence of SCG particles as an exfoliating material and a smoother formulation texture. Further evaluation of pH, moisturizing effect, and irritation response is required to determine whether this organoleptic advantage is accompanied by improved functional performance.

pH Evaluation of Body Scrub

The pH values of the body scrub formulations and control materials are presented in Figure 3 as mean ± standard deviation ($n = 3$). SCG used as a control exhibited a pH of 5.10 ± 0.10, whereas the F1 liquid soap had a pH of 9.50 ± 0.10. Following incorporation of these components into the body scrub formulations, the pH values were 7.87 ± 0.23 for V1, 7.70 ± 0.07 for V2, and 7.38 ± 0.38 for V3. Numerically, increasing the SCG content from 40% in V1 to 50% in V2 and 60% in V3, accompanied by a simultaneous decrease in liquid soap content from 57% to 47% and 37%, respectively, showed a progressive downward trend in formulation pH. However, one-way ANOVA indicated that the differences in pH among V1, V2, and V3 were not statistically significant [$F(2,6) = 2.781$, $p = 0.140$]. Tukey's HSD post hoc test further confirmed no significant differences between V1 and V2 ($p = 0.694$), V1 and V3 ($p = 0.127$), or V2 and V3 ($p = 0.360$). Thus, the three formulations exhibited statistically comparable pH values.

Although the differences were not statistically significant, the downward trend in mean pH can be interpreted based on the changing compositional balance between SCG and liquid soap, which exhibited distinctly different pH characteristics. The F1 liquid soap was alkaline, with a pH of 9.50 ± 0.10, whereas SCG exhibited a lower pH of 5.10 ± 0.10. In V1, the higher proportion of liquid soap and lower proportion of SCG maintained the formulation at a relatively higher pH. As the proportion of SCG increased in V2 and V3 while the liquid soap fraction decreased, the contribution of the lower-pH component increased, whereas the contribution of alkalinity from the soap phase decreased. Nevertheless, the absence of statistical significance indicates that the compositional changes within the investigated range did not produce a pH shift sufficiently large relative to the within-formulation variability to statistically distinguish V1, V2, and V3.

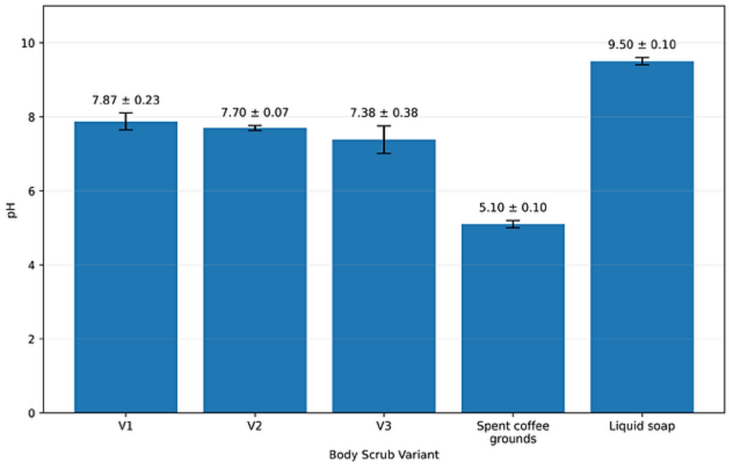

Fig 3. Mean pH values of the body scrub formulations and control materials. Error bars represent standard deviations (n = 3). The same lowercase letter indicates no significant difference among body scrub formulations according to one-way ANOVA followed by Tukey's HSD test ($p > 0.05$)

These findings can be compared with those of (Elezović et al., 2025), who developed SCG-based exfoliant products by incorporating different concentrations of SCG into several cosmetic formulation bases. Their results demonstrated that the pH response to increasing SCG content depended on the characteristics of the formulation base. For example, in formulation F11, increasing SCG content progressively shifted the pH from 6.02 without SCG to 5.78 at 2% SCG, 5.68 at 5% SCG, and 5.61 at 10% SCG. In other formulation bases, however, changes in pH with increasing SCG content were relatively small or followed different patterns. These results demonstrate that SCG does not act as an isolated determinant of formulation pH; rather, the final pH reflects the balance between the characteristics of SCG and the chemical properties of the carrier system. The same study further demonstrated that both SCG content and formulation-base characteristics influence the properties of SCG-containing exfoliant products.

The present study demonstrates a similar formulation-dependent principle, although substantially higher SCG concentrations were investigated. Increasing SCG from 40% to 60%, accompanied by a reduction in alkaline liquid soap from 57% to 37%, produced a numerical downward shift in pH from 7.87 to 7.38. Therefore, the pH trend observed across V1–V3 is more appropriately interpreted as a consequence of the changing SCG–liquid soap compositional balance, rather than solely as a direct effect of increasing SCG content. Furthermore, the lack of a statistically significant difference among V1, V2, and V3 indicates that the formulation system maintained relatively comparable pH characteristics despite substantial changes in the proportions of its two major components.

All three formulations exhibited mean pH values within the 4.5–8.0 range adopted in this study according to SNI 16-4399-1996. Thus, despite differences in the proportions of SCG and liquid soap, V1, V2, and V3 exhibited statistically comparable pH characteristics, with their mean values remaining within the adopted reference range. Compliance with this range should, however, be interpreted as pH conformity rather than evidence of product safety by itself, as safety assessment also requires irritation testing and other relevant safety evaluations.

Moisturizing effect and irritation evaluation of body scrub

The moisturizing effects and irritation responses of the body scrub formulations evaluated in 13 respondents are presented in Table 5. All respondents treated with V1 and V2 exhibited a positive moisturizing response, corresponding to 13/13 (100%) for each formulation, whereas no positive moisturizing response was observed for V3 according to the observational criteria used, corresponding to 0/13 (0%). In contrast, no itching, erythema (redness), or edema (swelling) was observed in any respondent following application of V1, V2, or V3 during the 30-min observation period. Thus, the observed incidence of irritation was 0/13 (0%) for all irritation parameters across the three formulations. These findings indicate that V1 and V2 produced an observational moisturizing response, while none of the three formulations produced observable signs of irritation under the conditions and observation period used in this study.

Table 5. Results of moisturizing and irritation evaluations of body scrub formulations.

Respondents	V1			
	It	Er	Ed	Mo
1	-	-	-	+
2	-	-	-	+
3	-	-	-	+
4	-	-	-	+
5	-	-	-	+
6	-	-	-	+
7	-	-	-	+
8	-	-	-	+
9	-	-	-	+
10	-	-	-	+
11	-	-	-	+
12	-	-	-	+
13	-	-	-	+

Respondents	V2			
	It	Er	Ed	Mo
1	-	-	-	+
2	-	-	-	+
3	-	-	-	+
4	-	-	-	+
5	-	-	-	+
6	-	-	-	+
7	-	-	-	+
8	-	-	-	+
9	-	-	-	+
10	-	-	-	+
11	-	-	-	+
12	-	-	-	+
13	-	-	-	+

Respondents	V3			
	It	Er	Ed	Mo
1	-	-	-	-
2	-	-	-	-
3	-	-	-	-
4	-	-	-	-
5	-	-	-	-
6	-	-	-	-
7	-	-	-	-
8	-	-	-	-
9	-	-	-	-
10	-	-	-	-
11	-	-	-	-
12	-	-	-	-
13	-	-	-	-

Notes:
It = Itching
Er = Erythema (Redness)
Ed = Edema (Swelling)
Mo = Moisturization
(+) = Reaction Observed
(-) = No. Reaction Observed

The difference in moisturizing response occurred concurrently with a systematic change in body scrub composition. The liquid soap content decreased from 57% in V1 to 47% in V2 and 37% in V3, whereas the SCG content increased from 40% to 50% and 60%, respectively, with cornstarch maintained at 3%.

This pattern indicates that the moisturizing response cannot be attributed to SCG content alone but is more appropriately interpreted in terms of the changing balance between the solid SCG fraction and the liquid soap phase. V1 and V2, which contained higher proportions of liquid soap, exhibited a positive moisturizing response in all respondents, whereas V3, containing the lowest liquid soap fraction and highest SCG fraction, did not. Thus, increasing the solid SCG fraction while simultaneously reducing the liquid soap phase appears to alter formulation characteristics associated with the skin moisturizing response after application.

This interpretation is relevant to the composition of the F1 liquid soap used as the carrier phase in all three formulations. F1 was prepared from waste cooking oil and olive oil. Bakhri et al., (2022) previously developed liquid soap containing olive oil as a component intended to provide a skin-moisturizing function. Findings more closely related to the formulation system investigated in the present study were reported by (Mapparessa et al., 2023) for hand soap based on waste cooking oil and olive oil, in which skin moisture and irritation were evaluated as skin-response parameters. Furthermore, (Bakhri et al., 2024) evaluated a scrub formulated with coffee grounds, Aloe vera, and liquid soap prepared from waste cooking oil, olive oil, and castor oil, including assessments of moisturizing effects and irritation. Collectively, these studies support the relevance of the oil-based carrier-phase composition to skin responses in cleansing and exfoliating products. Nevertheless, the moisturizing response observed in the present study cannot be attributed specifically to olive oil alone, because an otherwise identical control formulation without olive oil was not included. Therefore, the conclusion most directly supported by the experimental data is that V1 and V2, which contained higher proportions of the liquid soap phase, exhibited an observable moisturizing response, whereas V3 did not.

The importance of the balance between SCG and the formulation base is further supported by (Elezović et al., 2025), who incorporated SCG at different concentrations into several exfoliant formulation bases and evaluated product characteristics and skin-barrier responses. Their findings demonstrated that skin responses to SCG-containing products were influenced not only by the presence or concentration of SCG but also by the characteristics of the formulation base. This is consistent with the present findings because the change in moisturizing response across V1–V3 occurred as increasing SCG content was simultaneously accompanied by a reduction in the liquid soap phase. Therefore, the moisturizing response is more appropriately interpreted as an outcome of the SCG–carrier phase balance, rather than as an isolated effect of increasing SCG content.

The absence of itching, erythema, and edema in all respondents following application of V1, V2, and V3 indicates that no observable signs of irritation occurred during the evaluated period. This finding is generally consistent with (Mapparessa et al., 2023) and (Bakhri et al., 2024), which also evaluated irritation responses in cosmetic or cleansing formulations containing oil-based components and, in the latter study, coffee grounds. However, the present results should not be interpreted as evidence that the formulations are completely nonirritating or dermatologically proven to be safe. The evaluation involved only 13 respondents and a 30-min observation period; therefore, delayed reactions and nonvisible alterations in skin-barrier function could not be assessed.

The highly uniform moisturizing response: 100% for V1, 100% for V2, and 0% for V3, also warrants cautious interpretation. Moisturizing performance was evaluated using observation and questionnaire-based assessment with a binary (+/−) classification rather than quantitative measurements of skin hydration using an instrument such as a corneometer or assessment of transepidermal water loss (TEWL). Consequently, although the observed pattern demonstrates a clear difference in response according to the method used, the binary scoring system cannot quantify the magnitude of changes in skin hydration and has limited discriminatory sensitivity. This represents a limitation of the present study and supports the use of instrumental measurements of skin hydration and barrier function in future investigations. Overall, V1 and V2 exhibited an observational moisturizing response without observable signs of irritation, whereas V3 did not exhibit a moisturizing response but likewise produced no observable signs of irritation under the evaluated conditions.

CONCLUSION

Varying the proportions of SCG and waste cooking oil–olive oil-based liquid soap influenced the characteristics of the resulting body scrub formulations, particularly texture and the observed moisturizing response, while the pH values of the three formulations remained statistically comparable. Increasing SCG from 40% in V1 to 60% in V3, accompanied by a decrease in liquid soap from 57% to 37%, changed the texture from smooth to coarse and produced a numerical decrease in pH from 7.87 ± 0.23 to 7.38 ± 0.38. However, the differences in pH among V1, V2, and V3 were not statistically significant ($p = 0.140$), and all formulations remained within the pH range of 4.5–8.0 adopted in this study according to SNI 16-4399-1996. V1 and V2 exhibited positive moisturizing responses in all respondents (13/13; 100%), whereas V3 showed no positive moisturizing response (0/13; 0%). No itching, erythema, or edema was observed in any respondent following application of the three formulations during the 30-min observation period. Overall, V1 exhibited the most favorable combination of characteristics among the formulations evaluated, comprising a smooth texture, pH within the adopted reference range, an observed moisturizing response, and no observable signs of irritation under the conditions of this study.

These findings should be interpreted considering the limitations of the study, particularly the relatively small and homogeneous respondent population ($n = 13$; 18–22 years old), the short irritation-observation period, and the use of a binary observational (+/−) assessment rather than quantitative instrumental measurements of skin responses. Future studies should therefore evaluate the selected formulation in a larger and more diverse population, incorporate objective measurements of skin hydration and barrier function, extend the observation period for skin responses, and assess product stability during storage. Such investigations are needed to validate formulation performance and provide a stronger scientific basis for the further development of SCG-based body scrubs formulated with waste cooking oil–olive oil-based liquid soap.

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