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Formulation and Effectiveness of Bulung Sangu (*Gracilaria Gracilis*) Scrub for Skin Moisturization and Brightening

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ABSTRACT
Free radicals (UV rays) can damage skin cells; therefore, using skincare products containing antioxidants is essential. Antioxidants neutralize free radicals from UV rays, and a product's hallmark often influences people to purchase or experience its benefits. This experimental research aimed to determine the effectiveness of *bulung sangu* ingredients, formulated as fine powder in skincare scrubs. Four scrub samples were tested: *bulung sangu* (Formulation 1 and Formulation 2), without *bulung sangu* (Formulation 3), and *Bali Alus Seaweed* (Formulation 4). Thirty panelists from the Faculty of Agriculture, Udayana University, used the products for two weeks. Hedonic tests assessed appearance, aroma, color, and texture, alongside evaluations of skin moisture and brightness. Formulation 4 achieved the highest hedonic scores (78%, 79%, 81%, 83%), while Formulation 2 recorded the lowest (64%, 56%, 63%, 61%). Effectiveness tests showed Formulation 1 yielded the best results, improving skin moisture from normal to slightly moist (38% to 46%) and skin tone from tanned to bright white (15 to 9). Conversely, Formulation 4 presented the lowest effectiveness, with moisture at 41% to 44% and no change in skin tone (15). Outcomes were influenced by factors such as gene expression, environmental conditions, activity levels, physical condition, and ingredient preparation effectiveness.

INTRODUCTION

Human skin is the largest and heaviest organ composed of elastic tissue that functions to protect internal organs and defend the body from external exposures such as temperature, humidity, sunlight (UV), chemicals, and microorganisms. The average skin weight in adults is about 3.6 kg, with an area of approximately 1.9 m² (Mohania et al., 2017; Proksch, 2018; Sari, 2015; Sarkany, 2019; Walton et al., 2015; Z. Zhang & Michniak-Kohn, 2012). Skin damage can interfere with human health and is caused by several factors, one of which is exposure to free radicals from sunlight (UV), making the skin dry, rough, discolored, red, and prone to reactive oxygen species (ROS) formation (Astuti et al., 2018; Byrd et al., 2018; Dabrowska et al., 2016; Hofmann et al., 2023; Nachman & Franklin, 2016; Roger et al., 2019).

Geographically, Indonesia is located on the equator, where exposure to sunlight occurs almost every day, causing skin damage such as the evaporation of moisture content in the stratum corneum (SC) layer of the skin (AF et al., 2019). Considering these problems, a safe and effective solution is needed to protect and nourish the skin. One such solution is the use of skincare products containing antioxidant compounds. Antioxidants are chemical compounds

derived from the secondary metabolism of plants that stabilize free radicals from sunlight by completing unpaired chemical bonds (free radical acceptors) (Pachfule et al., 2019; Y. L. Zhang et al., 2020).

Skincare products are applied externally to clean, repair, care for, and nourish the body, requiring a period of consistent use to observe their effectiveness. One of the most promising and widely favored skincare products is scrubs, which help moisturize and brighten the skin. In addition, scrubs are often formulated using ingredients that contain antioxidant compounds and are developed with characteristics designed to attract consumers. Based on these considerations, the researcher aims to create a scrub (skincare) product that is safe and effective for all skin types.

Traditionally, scrubs are prepared in powder form using ingredients such as *bulung sangu*, kaffir lime peel, sea salt, and rice flour (white and red), without synthetic fragrance, preservatives, moisturizers, or dyes. Furthermore, this study includes comparison samples—scrubs formulated without *bulung sangu* (Formulation 3) and Bali Alus Seaweed Scrub (Formulation 4) (Barbosa et al., 2018; Capillo et al., 2018; Mouedden et al., 2024; Rasyid et al., 2019).

This research is essential for developing skincare products that moisturize and brighten the skin. To date, no studies have examined the hedonic aspects—appearance, aroma, color, and texture—or tested the moisturizing and brightening effectiveness of scrub products formulated with *bulung sangu*, kaffir lime peel, sea salt, and rice flour (white and red) in powder form.

Previous studies have investigated the potential of natural antioxidant-based skincare formulations; however, most have focused on single active ingredients without exploring synergistic effects among multiple natural components. Astuti et al. (2018) examined the antioxidant activity of natural extracts in protecting the skin from UV-induced oxidative stress, demonstrating that plant-derived compounds can effectively inhibit ROS formation. However, their study did not assess sensory acceptance or consumer perception (hedonic tests), which are crucial for product commercialization. Similarly, Haerani et al. (2018) investigated the role of natural antioxidants in enhancing skin hydration and preventing photoaging but focused solely on extract-based creams, lacking comparative evaluation across formulation types such as scrubs or exfoliants.

This research aims to analyze both the hedonic characteristics (appearance, aroma, color, texture) and the functional effectiveness of improving skin moisture and brightness. The findings are expected to contribute to the growing field of green cosmetic science by providing insights into sustainable skincare formulations that are safe, effective, and acceptable for consumers with diverse skin types. Furthermore, the study is expected to support future research on cosmeceutical innovation, particularly in optimizing the synergistic potential of local Indonesian bio-resources for skincare applications.

METHOD

The method used is a descriptive quantitative method using mean and total percentage values for the hedonic or preference test and the average value for the moisture and skin brightness effectiveness test. Hedonic test data or preference using a questionnaire through google forms.

The research was conducted from March to July 2025 at the Laboratory of Genetic Resources, Molecular Biology, Udayana University using 30 tested panelists (once using commercial scrubs) from the Academic Community (Students, Lecturers, and Employees) of the Faculty of Agriculture, Udayana University.

Table 1. Sample Body Scrub Formulation

Ingredient Composition	Scrub Sample (%)			
	Formula 1 (F1)	Formula 2 (F2)	Formula 3 (F3)	Formula 4 (F4)
Bulung Sangu Flour	20	40	0	Lulur Bali Alus Seaweed with VCO (50)
Sea Salt	50	30	40	
Rice Flour (white & red)	20	20	20	
Kaffir Lime Peel Flour	10	10	10	

Table 1 is the composition of the ingredients of Bulung Sangu scrub in the form of percentages. Formulation 1 has a composition of 20% bulung sangu (flour), 50% sea salt, 20% rice flour, and 10% kaffir lime peel (flour). Formulation 2 has a composition of 40% bulung sangu (flour), 30% sea salt, 20% rice flour, and 10% kaffir lime peel (flour). Formulation 3 has a composition of 0% bulung sangu (flour), 40% sea salt, 20% rice flour, and 10% kaffir lime peel (flour). Formulation 4 of Bali Alus Seaweed Commercial Scrub with VCO (50%)

Table 2. Skin Moisture Value Parameters

Skin Moisture Percentage (%)	Skin Type
≤ 33	Kering (dry)
34 – 37	Slightly Dry
38 – 42	Normal
43 – 46	Agak Lembab (Slightly moist)
≥ 47	Lembab (moist)

Table 3. Skin Brightness Value Parameters

Number Scale	Skin Type
1 – 5	Pale White
6 – 10	Bright White
11 – 15	São Paulo
16 – 20	Medium Chocolate
21 – 25	Dark Chocolate
26 – 30	Black

Table 3 is a table for measuring skin brightness values from Laksono (2017). In the study, the measurement of skin brightness levels was measured using the Skin Tones Check tool

Table 4. Hedonic Test Value and Percentage Parameters

Assessment Number Level	Criterion
1 (20 – 35)	Very Much Dislike
2 (36 – 51)	Dislike
3 (52 – 67)	Neutral
4 (68 – 83)	Like
5 (84 – 100)	Very Like

Table 4 is a percentage table of hedonic tests from De Jesus (2025). Measurement data is obtained using the following equations:

$$\%= n/N \times 100\ \%$$

Information:

% = Percentage Score

n = Total number of Quality Scores (appearance, aroma, color, and texture)

N = Ideal Score (Highest score x number of panelists)

The collected data were analyzed using descriptive statistics, including mean, standard deviation, and percentage. Quantitative comparisons between pre- and post-test values for skin moisture and brightness were analyzed using the paired sample t-test, while differences among formulations were examined using one-way ANOVA. Significance was set at $p < 0.05$. The hedonic data were analyzed by calculating the total percentage of preference scores and interpreting them based on the criteria outlined in Table 4. All statistical analyses were performed using SPSS version 26.0.

This study adhered to the ethical principles outlined by the Udayana University Research Ethics Committee. All participants were informed about the purpose, procedures, and potential risks of the study. Written informed consent was obtained prior to participation. Confidentiality and anonymity of respondents were maintained throughout the study, and participants were free to withdraw at any stage without consequence. The natural scrub formulations used were free from synthetic dyes, preservatives, and fragrances, ensuring participant safety during testing.

RESULTS AND DISCUSSION

Hedonic Test of Appearance and Aroma of Scrub

Table 5. Average Value and Percentage of Appearance and Aroma of Body Scrub Hedonic Test

Scrub Samples	Average Score Indicator		Percentage Indicator %	
	Appearance of Scrub	Aroma Scrub	Appearance of Scrub	Aroma Scrub
F1	3.2	2.9	64	58
F2	3.2	2.8	64	56
F3	3.3	3.1	66	62
F4	3.9	3.9	78	79

Table 5 explained that the F2 scrub had the lowest value from the hedonic test derived from the calculation and analysis of data from the questionnaire, namely 3.2 (64%) for the appearance of the scrub and 2.8 (56%) for the scent of the scrub. Meanwhile, the F4 scrub had the highest score from the hedonic test, namely 3.9 (78%) for the appearance of the scrub and 3.9 (79%) for the scent of the scrub.

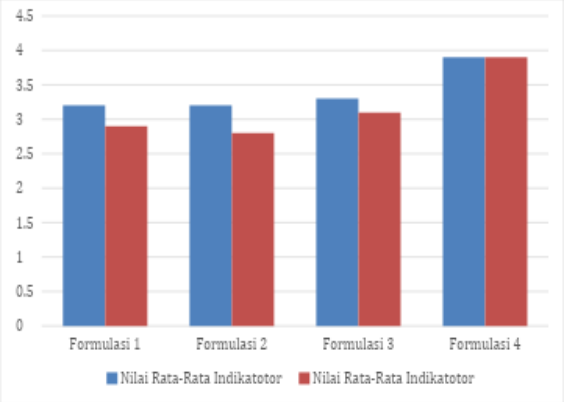

Figure 1. Hedonic Graph of the Appearance and Aroma of Scrub Formulation

Table 6. Normality test and Kruskal-Wallis test of Hedonic test

Scrub Samples	Indicator Normality Test		Kruskal-Wallis Test Indicator	
	Appearance of Scrub	Aroma Scrub	Appearance of Scrub	Aroma Scrub
F1	0.016	0.253	0.176	0.041
F2	0.078	0.012		
F3	0.023	0.109		
F4	0.018	0.002		

Table 6 explain the value of the statistical initial test for the identification of data from the hedonic test of the formulation of the normally distributed scrub or not by following the decision-making basis of Sig. < 0.05. The result obtained is that the data is not normally distributed because one of the data has a value according to the basis of decision-making, so for further analysis the Kruskal-Wallis test (non-parametric test) is used.

The results obtained from the follow-up analysis, the data from the aroma of the scrub has a value of 0.041 < 0.05 so that there are differences in each formulation of the scrub. Analysts to see differences in scrub scent use the Mann-Whitney test because it follows the previous analysis using a non-parametric test.

Table 7. Mann-Whitney Aroma of Body Scrub

Comparison of Scrub Samples	Mann-Whitney Test of Aroma Scrub	Notation Remarks (a = 0.05)
F3: F4	0.018	Real Difference (b)
F3: F1	0.495	No Real Difference (a)
F3: F2	0.332	No Real Difference (a)
F4: F1	0.012	Real Difference (b)
F4: F1	0.045	Real Difference (b)
F1: F2	0.372	No Real Difference (b)

The Mann-Whitney test aims to test the value of data by comparing one data with another differently by following the basis of decision-making, namely Sig. < 0.05, then there is a significant difference between the data being compared.

The results obtained, F1, F2, F3 have no real difference while F4 has a real difference in value. This is because the composition of the scrub ingredients, namely F1, F2, F3, has a composition of kaffir peel (flour) as an aroma. While F4 has an ingredient composition of

Fragrance, Olive (Olea europaea) Oil, and Chamomile (Chamomilla recuitita) Flower Oil as a scent

Hedonic Test of Color and Texture of Scrub

Table 8. Average Value and Percentage of Color and Texture of Body Scrub Hedonic Test

Scrub Samples	Average Score Indicator		Percentage Indicator %	
	Color Scrub	Scrub Texture	Color Scrub	Scrub Texture
F1	3.28	3.2	66	64
F2	3.13	3.03	63	61
F3	3.46	3.36	69	67
F4	4.07	4.1	81	83

Table 8 explained that the F2 scrub had the lowest value from the hedonic test derived from the calculation and analysis of data from the questionnaire, namely 3.13 (63%) for the color of the scrub and 3.03 (61%) for the texture of the scrub. Meanwhile, the F4 scrub had the highest score from the hedonic test, namely 4.07 (81%) for the color of the scrub and 4.1 (83%) for the texture of the scrub.

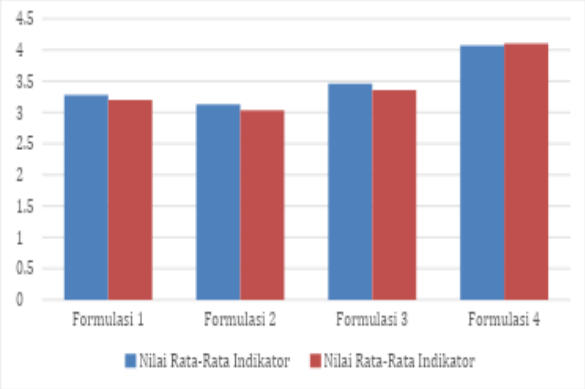

Figure 2. Hedonic Graph of Color and Texture of Scrub Formulation

Table 9. Normality test and Kruskal-Walis test of Hedonic test

Scrub Samples	Indicator Normality Test		Kruskal-Wallis Test Indicator	
	Scrub Color	Scrub Texture	Scrub Color	Scrub Texture
F1	0.148	0.152	0.067	0.018
F2	0.063	0.064		
F3	0.014	0.036		
F4	0.006	0.008		

The results obtained from Table 9 is that the data is not normally distributed because one of the data has a value according to the basis of decision-making (Sig.< 0.05). Then for further analysis using the Kruskal-Wallis test (non-parametric test) has a value of 0.018 < 0.05 so that there is a difference in each scrub formulation. Analysts to see differences in scrub texture using the Mann-Whitney test as it follows the previous analysis using a non-parametric test

Table 10. Mann-Whitney Aroma of Body Scrub

Comparison of Scrub Samples	Mann-Whitney Test of Scrub Texture	Notation Remarks (a = 0.05)
F3:F4	0.022	Real Difference (b)
F3:F1	0.744	No Real Difference (a)
F3:F2	0.396	No Real Difference (a)
F4:F1	0.027	Real Difference (b)
F4:F1	0.006	Real Difference (b)
F1:F2	0.618	No Real Difference (b)

The results obtained, F1, F2, F3 have no real difference while F4 has a real difference in value. This is because the composition of the scrub ingredients, namely F1, F2, F3, has the composition of ingredients in the form of flour and the addition of sea salt so that the texture of the scrub is rough. While F4 has a composition of Olive (Olea europaea) Oil, Chamomile (Chamomilla recuitita) Flower Oil, Aqua, and Milk Protein ingredients so that the texture of the scrub is smooth.

Figure 3. Body Scrub Formulation Sample

Test the Effectiveness of Scrubs on Skin Moisture and Brightness

Table 11. Average Value of Effectiveness Test of Scrub Formulation Samples

Location of Scrub Usage	Skin Moisture %		Skin Tone Brightness	
	Before Use	After Use	Before Use	After Use
Right Hand (F1)	38	46	14	9
Left Hand (F2)	39	45	14	10
Back of the Right Hand (F3)	39	43	15	10
Back of the Left Hand (F4)	41	44	14	11

Table 11. Explain the average value of the moisture and skin brightness effectiveness test derived from the calculation and analysis of data on the measurement of the use of before and after the use of the scrub for two weeks as many as six times before going to bed at night.

The results of the scrub effectiveness test showed that the average value (Table 11.) of skin moisture and brightness before and after the application of the scrub formulation, the F1 sample used on the right hand had the highest effectiveness level value. While F4 used on the back of the left hand has the lowest level of effectiveness value. The value is, before the use of bulung sangu scrub, F1 has a skin moisture value of 38% which is classified as normal skin and a skin brightness value (14) which is classified as tan type skin. Then after using F1 bulung sangu scrub, the skin moisture value was 46% which was classified as slightly moist skin (slight moist) and the skin brightness value (9) which was classified as light white skin. For the F4 sample from the Bali Alus Seaweed scrub, before using the scrub it had a skin moisture of 41%

which was classified as normal skin and skin brightness (14) which was classified as tan skin. Then, after the use of Bali Alus Seaweed scrub, the skin moisture value of 44% which is classified as slightly moist skin and the skin brightness value (11) which is classified as tan skin. The division of moisture and skin brightness can be seen in Table 2. and Table 3.

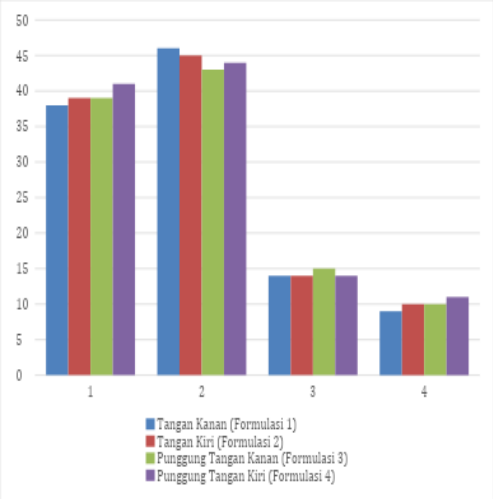

Figure 4. Effectiveness of Body Scrub Graph

Table 12. Number of People Tested of Skin Moisture (Before Using Body Scrub)

Skin Moisture Percentage	Number of People (Before Use)			
	Right Hand	Left Hand	Back of the Right Hand	Back of the Left Hand
≤ 33	7	7	4	1
34 – 37	7	6	6	8
38 – 42	6	4	12	9
43 – 46	6	9	5	5
≥47	4	4	3	7

Table 13. Number of People Tested of Skin Moisture (After Using Body Scrub)

Skin Moisture Percentage	Number of Panelists (After Use)			
	Right Hand	Left Hand	Back of the Right Hand	Back of the Left Hand
≤ 33	-	-	-	-
34 – 37	-	-	2	4
38 – 42	5	5	9	6
43 – 46	7	7	14	10
≥47	18	18	5	10

Table 13 can be strengthened by looking at the number of people at each measurement value on skin moisture before and after the application of the scrub (Table 12. and Table 13.). The number of people who have skin moisture on the right hand with dry (<33) and slightly dry (34 – 37) skin types has a total of 14 people (before the use of the scrub) to 0 people (after the use of the scrub)

Figure 5. Skin Moisture Before Applying Scrub

Figure 6. Skin Moisture After Using Scrub

Table 14. Number of People Tested of Skin Brightening (Before Using Body Scrub)

Skin Moisture Percentage	Number of People (Before Use)			
	Right Hand	Left Hand	Back of the Right Hand	Back of the Left Hand
1 – 5	-	-	-	-
6 – 10	5	5	8	7
11 – 15	16	16	10	15
16 – 20	4	4	6	4
21 – 25	5	5	6	4
26 – 30	-	-	-	-

Table 15. Number of People Tested of Skin Brightening (Before Using Body Scrub)

Skin Moisture Percentage	Number of People (After Use)			
	Right Hand	Left Hand	Back of the Right Hand	Back of the Left Hand
1 – 5	5	5	5	1
6 – 10	18	19	16	16
11 – 15	5	5	6	8
16 – 20	2	1	3	5
21 – 25	-	-	-	-
26 – 30	-	-	-	-

Then F1 has a skin brightness value (14) which is classified as tan type skin (before the use of scrubs) to a skin brightness value (9) which is classified as light white skin which can be seen in Table 3.

Figure 7. Skin Brightness Before Applying Scrub

Figure 8. Skin Brightness After Applying Scrub

The difference in the effectiveness of scrub formulations (F1 to F4) on moisture and skin brightness before and after use is due to various factors. First, internal factors such as gene expression that produce more melanin cells than the MSH hormone that works actively continuously. Second, environmental factors, such as being in a room with too hot or exposed to sunlight and too cold to be exposed to Air Conditioner (AC). Third, activity factors and body conditions such as lack of nutritional and fluid intake in the body and the type of clothing worn. Fourth, the effectiveness factor of scrub ingredients. The preparation of scrub formulation ingredients The ingredients of the bulung sangu scrub use ingredients from bulung sangu, sea salt, kaffir lime peel, and rice flour

Meanwhile, the composition of the Bali Alus Seaweed scrub is Algae Extract (unknown type of seaweed), Coconut (Cocos nucifera) Extract, Fragrance (can be natural or synthetic), Olive (Olea europaea) Oil, Oryza sativa Bran Extract, Propylparaben, Chamomilla recutita Flower Oil, Aqua, Cera-Alba, Methylparaben, and Milk Protein.

Table 16. Ingredients Body Scrub

Ingredient Composition	Benefits	Active Compounds
Bulung Sangu	Antioxidant, Anti-Inflammatory, and Antimicrobial	Asam n-hexadecanoic, [1,2,4] triazolo [4,3-a] quinoline; Phytol; Heptadecane; 6-Hydroxy-4,4,7a-trimethyl-5,6,7,7a-etrahydro benzofuran-2(4H)-one; asam Hexadecanoic; 2-hydroxy-1-(hydroxymethyl) ethyl ester; Asam benzoic, dan Gliserin
Kaffir Lime (Skin)	Antioxidant, Antimicrobial, Anti-inflammatory, Repellant, *Anti-aging*, and Aroma therapy	Alkaloids, flavonoids, terpenoids, saponins, tannins, and essential oils (*limonene* and *citronellol*)
White Rice Flour	Blocks UV radiation, regulates collagen production, Brightens skin, and Prevents acne-prone skin	Gamma oryzanol and Kojic Acid
Brown Rice Flour	Cleanses dead and damaged skin cells, maintains *the skin barrier,* accelerates the regeneration of new skin cells, Opens skin pores, and prevents dull skin	Proantosinanidin
Sea Salt	Antibacterial, Anti-Inflammatory, Body Detoxification (in), Removing dead skin cells from skin pores, Drawing water (*hygroscopic*)	Natural minerals from the ocean (calcium, sodium, and magnesium)
Coconut Extract	Accelerates the regeneration of skin cells and tissues, Softens the skin, Protects the skin from UV rays, and Gives the skin a glow	Lauric Acid, Vitamin E, Magnesium, Calcium, and Vitamin K
Olive Oil	Accelerates burn closure, anti-inflammatory, antimicrobial, and skin cell care (body and hair)	Oleic acid, Polyphenols, Vitamin E, and Squalene.
Oryza sativa Bran	Antidiabetes, Antibacterial, antioxidant	Gamma oryzanol
Chamomile *(Chamomilla recuitita)* Flower Oil	Treats skin disorders (such as burns, bite bruises, skin irritations, ulcers, chickenpox, and insect bites), Antioxidants,	Flavonoid, Apigenin, Luteolin, dan Terpenoid.
Milk Protein	Accelerates wound healing, Kills microbes/microorganisms in wounds,	Kasein, Lactoferrin, dan Asam amino

Ingredient Composition	Benefits	Active Compounds
	Anti-aging, Moisturizes skin, Soothes skin cells, Repairs skin cells, and Whitens skin	

CONCLUSION

The hedonic test results showed that the F4 scrub from Bali Alus Seaweed Traditional Spa with VCO achieved the highest scores in appearance, aroma, color, and texture, while the F2 scrub formulated with *bulung sangu* (40%), sea salt (30%), rice flour (20%), and kaffir lime peel (10%) obtained the lowest values, primarily due to differences in ingredient composition affecting aroma and texture. Significant improvements were observed before and after scrub use across all formulations, influenced by factors such as gene expression related to the MSH hormone, environmental conditions, physical activity, and body condition. Future research should explore optimizing natural ingredient ratios in *bulung sangu*-based formulations and investigate molecular mechanisms linking bioactive compounds to skin brightness and hydration effects.

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