Advances in Healthcare Research
Volume 3, Issue 2 (2025)
Website: https://advancesinresearch.id/index.php/AHR
OPEN ACCESS
e-ISSN: 2985-9808

Formulation and Physical Quality Testing of Cleansing Balm from Centella Asiatica (L.) URB. Extract with Castor Oil (Ricinus Communis L.) as a Makeup Remover

Sevty Ardhia Pramesty [1*] Hasriyani [2] Bintari Tri Sukoharjanti [3]

[1] Universitas Muhammadiyah Kudus, Kudus, Indonesia. Email: sevtypramesty123@gmail.com
[2] Universitas Muhammadiyah Kudus, Kudus, Indonesia. Email: hasriyani@umkudus.ac.id
[3] Universitas Muhammadiyah Kudus, Kudus, Indonesia. Email: bintaritri@umkudus.ac.id

ARTICLE HISTORY

Received: July 25, 2025
Revised: August 09, 2025
Accepted: August 14, 2025

DOI :
https://doi.org/10.60079/ahr.v3i2.597

ABSTRACT

Purpose: This study aimed to formulate and evaluate the physical quality of cleansing balm containing 3% Centella asiatica (L.). Urb. Extract with castor oil (Ricinus communis L.) at varying concentrations (30%, 35%, and 40%) to determine the optimal formulation as an effective and safe makeup remover.
Research Method: An experimental laboratory design was conducted at the Cendekia Utama Kudus Institute of Health Technology. The Centella asiatica extract was obtained from UPT Lab Herbal Materia Medica Batu, East Java. Physical quality tests included organoleptic, homogeneity, pH, spreadability, adhesion, melting point, cleansing ability, and skin irritation tests. Data analysis was performed using SPSS, including tests for normality, homogeneity, One-Way ANOVA, and post hoc Tukey tests. Six female volunteers aged 18–30 participated in the irritation test.
Results and Discussion: All formulations met physical quality standards. Formula 1 (3% Centella asiatica + 30% castor oil) demonstrated optimal results, exhibiting the best cleansing ability, easy rinsing, an ideal pH (5.61), good spreadability (4.91 cm), the highest adhesion (13.43 s), and no irritation in any of the volunteers and increasing the castor oil content above 35% reduced cleansing effectiveness, despite improving spreadability. No formulation caused erythema or edema during the 72-hour observation.
Implications: The findings support the potential use of Centella asiatica and castor oil in natural, safe, and effective cleansing balm formulations. Future research should assess long-term stability, consumer acceptance, and potential scalability for commercial production.

Keywords: centella asiatica; castor oil; cleansing balm; physical quality; makeup remover.

Introduction

The process of cleansing the skin is a basic human need that aims to help maintain the skin's physiological condition, ensuring it remains normal. Skin cleansing has a rejuvenating effect on the skin, keeping it healthy and vibrant. The use of cleansing products is a crucial step that should be considered as the first step in an overall skincare routine. The use of cleansing products is intended to remove dead skin cells, dirt, sebum, and cosmetics (Diah, 2019). Currently, facial makeup, commonly referred to as

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e-ISSN: 2985-9808

makeup, is an activity aimed at altering or enhancing one's appearance using cosmetic tools and products. The use of makeup has become a daily necessity, particularly for women, as it helps boost their self-esteem and confidence. However, the process of removing makeup is a crucial step that is often overlooked or not performed correctly. Residual makeup that accumulates on the face can lead to the onset of skin issues such as acne, blackheads, and even irritation. Acne is one of the most common skin problems, particularly among teenagers today. Several studies indicate that acne can be caused by various factors, including increased sebum production, clogged pores, and inflammation due to bacterial infection by Propionibacterium acnes (Vasam, 2023). Acne-prone skin requires special attention in daily skincare routines, especially when removing makeup. Makeup that is not thoroughly removed can clog pores, increase the likelihood of inflammation, and worsen acne issues. There is also concern that using some effective cleansers that remove sebum may cause the skin to become very dry and sensitive. Therefore, an ideal facial cleanser must be able to meet two opposing needs: removing sebum while maintaining skin moisture (Spada & Harrison, 2022). Thus, it is essential to choose a cleanser that is not only effective at cleansing but also helps reduce inflammation and accelerate the healing process of acne or other skin issues. A mild, fragrance-free, and non-irritating cleanser with good rinsing properties is highly recommended for managing acne (Spada & Harrison, 2022).

Cleansing balm is a semi-solid facial cleanser composed of a combination of oils and waxes, specifically designed to gently remove makeup, dirt, and sunscreen from the skin. At room temperature, cleansing balm has a consistency similar to that of a balm. Still, it melts into oil when applied to warm skin, facilitating the cleansing process without stripping the skin of its natural moisture (Sukma Wibowo et al., 2024). Cleansing balm is a skin cleanser that utilizes a biphasic composition, a cosmetic formulation consisting of two phases—an aqueous phase and an oil phase—forming an emulsion that results in a homogeneous mixture. The emollient content in cleansing balm has a positive effect on various skin conditions, including regular, dry, oily, and combination skin, due to its ability to hydrate the skin and its tolerance for sensitive skin (Nur et al., 2020). Pegagan Centella asiatica (L.) Urb. also known by its synonym Hydrocotyle asiatica L. from the Apiaceae family, is commonly referred to as gotu kola or Indian pennywort. This plant is native to tropical regions, including Asia, India, Africa, Madagascar, Central America, and South America. Pegagan is a creeping herb with round, kidney-shaped leaves with serrated edges, reddish stems, and white to pink flowers (Harun et al., 2019). This plant is often found growing wild in plantations, fields, roadside areas, and other moist locations. Previous studies have demonstrated that Centella asiatica (L.) Urb. Possesses pharmacological activities such as anti-aging, anticancer, antibacterial, antioxidant, and antidiabetic properties, accelerates wound healing, exhibits antifungal and anti-inflammatory effects, and is used in the treatment of Alzheimer's disease (Amallia et al., 2020).

The most important active compounds in pegagan are triterpenoids and saponins, including asiaticoside, centelloside, madecassoside, and asiatic acid, as well as other components such as volatile oils, flavonoids, tannins, phytosterols, amino acids, and carbohydrates (Yousaf et al., 2019). As we know, Centella asiatica (L.) Urb. Extract, commonly known as cica, is widely used as an active ingredient in various skincare and cosmetic products that claim to have a calming effect on redness caused by acne. All the bioactive compounds in Centella asiatica are antioxidants that are beneficial for boosting the immune system. Triterpenoids, as the dominant compounds, function to enhance memory, mental function, and provide a calming effect. Asiatic acid, asiaticoside, and madecassic acid have been proven effective in regenerating skin tissue, improving the extracellular matrix through collagen production,

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and reducing melanin content in melanocytes, making Centella asiatica a potential active ingredient for skin-lightening in cosmetics (Fernenda et al., 2023).

Castor oil is obtained from the seeds of the castor plant (Ricinus communis L), which contains approximately 80-90% ricinoleic acid glycerides. Castor oil, as a base in cleansing balm formulations, falls under the category of superlating oils, which excel in moisturizing and softening the skin (Widyasanti et al., 2019). The presence of ricinoleic acid, the most dominant component, makes castor oil more polar than other vegetable oils, endowing it with hydrophilic properties and making it highly suitable for use as a cleansing product (Rachmadani et al., 2022). Based on previous research conducted by Sukma Wibowo et al. (2024) at the Pharmaceutical Technology Laboratory of Singaperbangsa Karawang University, the formulation of a cleansing balm made from castor oil and pure coconut oil was evaluated. The results showed that the cleansing balm formulation met physical and chemical quality standards and demonstrated practical cleansing efficacy in removing makeup, with the best cleansing performance at a coconut oil concentration of 20% and castor oil at 35%. The abundance of cleansing products containing harsh chemicals in the market poses a risk of skin irritation, necessitating alternatives based on natural ingredients. The combination of Centella asiatica extract, an active ingredient with beneficial compounds for the skin, and castor oil, used as the base in the cleansing balm formulation, is expected to enhance cleaning efficacy while also serving as a skin care product. Based on the background described above and the advantages of Centella asiatica and castor oil, the researcher aims to conduct physical quality testing of Centella asiatica extract (Centella asiatica (L.) Urb.) extract at a concentration of 3% and castor oil (Ricinus communis L.) as a base with varying concentrations of 30%, 35%, and 40% in a cleansing balm formulation to assess its effectiveness as a makeup remover.

Literature Review and Hypothesis Development

Pegagan (Centella asiatica (L.) Urb.)

Pegagan, commonly known as Centella asiatica (L.) Urb. is a plant belonging to the Umbelliferae family. In the United Kingdom, peganum leaves are widely known as pennywort, whereas in the Americas, they are referred to as gotu kola. This plant originates from the tropical regions of Asia and has spread to various countries, including the Philippines, China, India, Sri Lanka, Madagascar, and Indonesia (Susetyarini & Nurrohman, 2022). Pegagan (Centella asiatica (L.) Urban) has skin-healing properties, including wound healing, infection prevention, burn treatment, keloid reduction, antioxidant activity, anti-photoaging effects, anti-inflammatory properties, skin lightening, moisturization, and cellulite reduction, as demonstrated by both preclinical and clinical studies. Several active compounds in pegagan, which play a role in dermatology, have been proven to be safe and non-toxic, with rare side effects (Fernanda et al., 2023).

Castor oil (Ricinus communis L.)

Castor oil is a vegetable oil produced through an extraction process using pressing or solvent extraction of the seeds of the castor plant (Ricinus communis L.), which is commonly grown in Africa, South America, and Asia. Castor oil contains high levels of oleic and linoleic fatty acids. Oils with these fatty acid contents can be used as emollients or oil bases in the formulation of cleansing balms (Widyasanti et al., 2019). Previous studies have also reported that castor plants possess therapeutic

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properties, such as antiasthmatic, antidiabetic, anticancer, antioxidant, antimicrobial, anti-inflammatory, antiulcer, wound-healing, and laxative effects (Nour et al., 2023).

Cleansing balm

Cleansing balm is a cleansing product in the form of an oil-in-water emulsion with a balm-like texture and a distinctive oil scent, designed to gently remove makeup, sunscreen, and other impurities from the face (Nur et al., 2020). Cleansing balm works by hydrating residual impurities during the cleansing process. Its mechanism of action follows the "like dissolves like" principle, where the oil phase functions to lift lipophilic (oil-soluble) dirt particles that are difficult to remove with water alone. On the other hand, the water phase is necessary to cleanse hydrophilic (water-soluble) particles (Yu et al., 2019). The general formulation of cleansing balms includes emollients, consistency enhancers, emulsifiers, and water (Nur et al., 2020). The composition of cleansing balms consists of various combinations of one or more ingredients, including structural agents or consistency enhancers, emollients, emulsifiers, active ingredients, and other additives.

Research Method

This study used an experimental research design. It was a laboratory experimental study that involved the formulation and evaluation of the physical quality of a cleansing balm made from Centella asiatica (Centella asiatica (L.) Urban) extract with castor oil (Ricinus communis L.) as the base ingredient, based on physical parameters and skin irritation potential. The formulation and physical quality testing were conducted at the Laboratory of the Cendekia Utama Health Technology Institute in Kudus. The population in this study was Centella asiatica (Centella asiatica (L.) Urban) plants obtained from the UPT Lab, Herbal Materia Medica Batu, East Java. For the skin irritation test population, the study was conducted at Muhammadiyah University Kudus with respondents from the student population. The sample used in this study was a crude extract of pegagan (Centella asiatica (L.) Urban), weighing 400g, extracted with a 70% ethanol solvent at a ratio of 1:10, obtained from the UPT Lab Herbal Materia Medica in Batu, East Java. The irritation test samples were administered to 6 female volunteers aged 18–30 years who met the inclusion criteria and did not meet the exclusion criteria.

This study employed an observational data collection method. Observation is a data collection technique used in experiments to assess the physical quality of cleansing balm preparations based on several formulation criteria (Sukoharjanti et al., 2024). Additionally, observations were conducted on the skin reactions of volunteers after the irritation test to evaluate the safety aspects of the formulation. The data analysis technique used in this study employed the Analysis Package for the Social Sciences (SPSS) with the One-Way Analysis of Variance (ANOVA) statistical test. Quantitative data obtained from physical quality and efficacy tests were analyzed using statistical methods, including normality tests, homogeneity tests, and ANOVA tests, followed by Post-Hoc Tests.

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Results and Discussion

Analysis Result

Table 1. Organoleptic Test Results for Cleansing Balm

Formulation	Shape	Color	Smell
F0 (negative control)	Semi-solid	Milky white	Typical lavender
F1	Semi-solid	Light green	Typical lavender
F2	Semi-solid	Light green	Typical lavender
F3	Semi-solid	Light green	Typical lavender

Table 2. Data from Homogeneity Test Results for Cleansing Balm

Formula	Results
F0 (pegagan 0% + castor oil 0%)	Homogen
F1 (pegagan 3% + castor oil 30%)	Homogen
F2 (pegagan 3% + castor oil 35%)	Homogen
F3 (pegagan 3% + castor oil 40%)	Homogen

Table 3. pH Test Results for Cleansing Balm

Formula	pH			Average
	Replication 1	Replication 2	Replication 3	
F0	5,55	5,56	5,60	5,57
F1	5,60	5,63	5,61	5,61
F2	5,64	5,66	5,67	5,65
F3	5,71	5,73	5,74	5,72

Table 4. Data on the results of the cleansing balm spreading power test

Formula	Spread Power (cm)			Average
	Replication 1	Replication 2	Replication 3	
F0	4,20	4,15	4,25	4,20
F1	4,98	4,90	4,85	4,91
F2	5,03	5,10	5,00	5,04
F3	5,50	5,55	5,45	5,50

Table 5. Data from Adhesion Test Results for Cleansing Balm

Formula	Spread Power (detik)			Average
	Replication 1	Replication 2	Replication 3	
F0	6,35	6,40	6,30	6,35
F1	13,44	13,10	13,75	13,43
F2	10,95	10,80	11,10	10,95
F3	10,04	9,95	10,15	10,04

Table 6. Data from the melting point test of cleansing balm

Formula	Titik Leleh ()			Average
	Replication 1	Replication 2	Replication 3	
F0	40	36	37	37,67
F1	38	35	37	36,67
F2	37	36	35	36
F3	35	37	36	36

Advances in Healthcare Research
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Website: https://advancesinresearch.id/index.php/AHR
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e-ISSN: 2985-9808

Table 7. Data on the results of the cleansing balm's cleansing power test

Formula	Contents	Cleaning power	Effect after rinsing	Description
F0	extract pegagan 0% + castor oil 0%	Low	Slightly oily	Low cleaning power, difficult to rinse
F1	extract pegagan 3% + castor oil 30%	Best	Oil-free	Best cleaning power and easy to rinse
F2	extract pegagan 3% + castor oil 35%	Good	Oil-free	Good cleaning power and easy to rinse off
F3	extract pegagan 3% + castor oil 40%	Moderate	Oil-free	Decreased cleaning power and easy rinsing

Table 8. Irritation Test Results for Cleansing Balm

Time	Formula	Type Irritation	Respondent					
			R1	R2	R3	R4	R5	R6
0th hour	F0	Eritema	0	0	0	0	0	0
		Edema	0	0	0	0	0	0
	F1	Eritema	0	0	0	0	0	0
		Edema	0	0	0	0	0	0
	F2	Eritema	0	0	0	0	0	0
		Edema	0	0	0	0	0	0
	F3	Eritema	0	0	0	0	0	0
		Edema	0	0	0	0	0	0
24th hour	F0	Eritema	0	0	0	0	0	0
		Edema	0	0	0	0	0	0
	F1	Eritema	0	0	0	0	0	0
		Edema	0	0	0	0	0	0
	F2	Eritema	0	0	0	0	0	0
		Edema	0	0	0	0	0	0
	F3	Eritema	0	0	0	0	0	0
		Edema	0	0	0	0	0	0
48th hour	F0	Eritema	0	0	0	0	0	0
		Edema	0	0	0	0	0	0
	F1	Eritema	0	0	0	0	0	0
		Edema	0	0	0	0	0	0
	F2	Eritema	0	0	0	0	0	0
		Edema	0	0	0	0	0	0
	F3	Eritema	0	0	0	0	0	0
		Edema	0	0	0	0	0	0
72nd hour	F0	Eritema	0	0	0	0	0	0
		Edema	0	0	0	0	0	0
	F1	Eritema	0	0	0	0	0	0
		Edema	0	0	0	0	0	0
	F2	Eritema	0	0	0	0	0	0
		Edema	0	0	0	0	0	0
	F3	Eritema	0	0	0	0	0	0
		Edema	0	0	0	0	0	0
Irritation index	F0		0	0	0	0	0	0
	F1		0	0	0	0	0	0
	F2		0	0	0	0	0	0
	F3		0	0	0	0	0	0

SPSS Data Analysis

Normality Test

The Shapiro-Wilk normality test yielded a significance value ($p > 0.05$) in all test formulas, including the pH test, spreading power test, adhesion test, and melting point test, indicating that all

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data were normally distributed. This is based on the significance requirement of p> 0.05. The normality test results are shown in Table 9.

Table 9. Normalcy Test Results

		Shapiro-Wilk		
	Formula	Statistic	df	Sig.
pH test	F0	.964	3	.637
	F1	1.000	3	1.000
	F2	.964	3	.637
	F3	.964	3	.637
Dispersion Test	F0	1.000	3	1.000
	F1	.983	3	.747
	F2	.949	3	.567
	F3	1.000	3	1.000
Adhesion Test	F0	1.000	3	1.000
	F1	.999	3	.949
	F2	1.000	3	1.000
	F3	.997	3	.890
Melting Point Test	F0	.923	3	.463
	F1	.964	3	.637
	F2	1.000	3	1.000
	F3	1.000	3	1.000

Homogeneity Test

Based on the homogeneity test using the Kruskal-Wallis test in Table 10, the results showed significance. >0.05 for all calculation methods. Therefore, it can be concluded that the data between each test formula, including the pH test, spreading power test, adhesion test, and melting point test, are homogeneous or have uniform variance, thus meeting the requirements to proceed to the One-Way ANOVA test. (homogeneity requirement >0.05). The results of the homogeneity test are presented in Table 10.

Table 10. Homogeneity Test Results

		Levene Statistic	df1	df2	Sig.
pH test	Based on Mean	.970	3	8	.453
	Based on Median	.182	3	8	.906
	Based on Median and with adjusted df	.182	3	4.939	.904
	Based on the trimmed mean	.879	3	8	.492
Dispersion Test	Based on Mean	.148	3	8	.928
	Based on Median	.066	3	8	.976
	Based on Median and with adjusted df	.066	3	7.369	.976
	Based on the trimmed mean	.142	3	8	.932
Adhesion Test	Based on Mean	1.776	3	8	.229
	Based on Median	1.618	3	8	.260
	Based on Median and with adjusted df	1.618	3	3.365	.338
	Based on the trimmed mean	1.767	3	8	.231
Melting Point Test	Based on Mean	1.173	3	8	.379
	Based on Median	.306	3	8	.821
	Based on Median and with adjusted df	.306	3	4.800	.821
	Based on the trimmed mean	1.093	3	8	.406

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One-Way ANOVA test

The ANOVA test yielded a significant result. A value of <0.001 in the pH test, spreading power test, and adhesion test results indicates substantial differences between the four formulas in each test. Meanwhile, the melting point test yielded a significant result. The value of 0.500 is greater than 0.05, indicating no significant difference between the melting points of the four formulations (sig.). > 0.05 means no significant difference.

Table 11. Data from One-Way ANOVA Test Results

		Sum of Squares	df	Mean Square	F	Sig.
pH test	Between Groups	401.667	3	133.889	38.254	<.001
	Within Groups	28.000	8	3.500		
	Total	429.667	11			
Dispersion Test	Between Groups	26098.000	3	8699.333	291.598	<.001
	Within Groups	238.667	8	29.833		
	Total	26336.667	11			
Adhesion Test	Between Groups	775238.250	3	258412.750	734.475	<.001
	Within Groups	2814.667	8	351.833		
	Total	778052.917	11			
Melting Point Test	Between Groups	5.583	3	1.861	.859	.500
	Within Groups	17.333	8	2.167		
	Total	22.917	11			

post-Hoc Tukey Test

Table 12. Data from Tukey's Post-hoc Test pH

Multiple Comparisons
Dependent Variable: ph
Tukey HSD

		Mean			95% Confidence Interval	
(I) formula	(J) formula	Difference (I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
f0	f1	-4.33333	1.52753	.084	-9.2250	.5583
	f2	-8.66667*	1.52753	.002	-13.5583	-3.7750
	f3	-15.66667*	1.52753	<.001	-20.5583	-10.7750
f1	f0	4.33333	1.52753	.084	-.5583	9.2250
	f2	-4.33333	1.52753	.084	-9.2250	.5583
	f3	-11.33333*	1.52753	<.001	-16.2250	-6.4417
f2	f0	8.66667*	1.52753	.002	3.7750	13.5583
	f1	4.33333	1.52753	.084	-.5583	9.2250
	f3	-7.00000*	1.52753	.008	-11.8917	-2.1083
f3	f0	15.66667*	1.52753	<.001	10.7750	20.5583
	f1	11.33333*	1.52753	<.001	6.4417	16.2250
	f2	7.00000*	1.52753	.008	2.1083	11.8917

*. The mean difference is significant at the 0.05 level.

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Website: https://advancesinresearch.id/index.php/AHR
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e-ISSN: 2985-9808

Table 13. Data from Tukey's Post-Hoc Test of Dispersion Power

Multiple Comparisons
Dependent Variable: dayasebar
Tukey HSD

(I) formula	(J) formula	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
f0	f1	-71.00000*	4.45970	<.001	-85.2815	-56.7185
	f2	-84.33333*	4.45970	<.001	-98.6148	-70.0518
	f3	-130.00000*	4.45970	<.001	-144.2815	-115.7185
f1	f0	71.00000*	4.45970	<.001	56.7185	85.2815
	f2	-13.33333	4.45970	.067	-27.6148	.9482
	f3	-59.00000*	4.45970	<.001	-73.2815	-44.7185
f2	f0	84.33333*	4.45970	<.001	70.0518	98.6148
	f1	13.33333	4.45970	.067	-.9482	27.6148
	f3	-45.66667*	4.45970	<.001	-59.9482	-31.3852
f3	f0	130.00000*	4.45970	<.001	115.7185	144.2815
	f1	59.00000*	4.45970	<.001	44.7185	73.2815
	f2	45.66667*	4.45970	<.001	31.3852	59.9482

*. The mean difference is significant at the 0.05 level.

Table 14. Data from Tukey's Post-Hoc Test of Adhesive Strength

Multiple Comparisons
Dependent Variable: dayalekat
Tukey HSD

(I) formula	(J) formula	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
f0	f1	-708.00000*	15.31521	<.001	-757.0447	-658.9553
	f2	-460.00000*	15.31521	<.001	-509.0447	-410.9553
	f3	-369.66667*	15.31521	<.001	-418.7113	-320.6220
f1	f0	708.00000*	15.31521	<.001	658.9553	757.0447
	f2	248.00000*	15.31521	<.001	198.9553	297.0447
	f3	338.33333*	15.31521	<.001	289.2887	387.3780
f2	f0	460.00000*	15.31521	<.001	410.9553	509.0447
	f1	-248.00000*	15.31521	<.001	-297.0447	-198.9553
	f3	90.33333*	15.31521	.002	41.2887	139.3780
f3	f0	369.66667*	15.31521	<.001	320.6220	418.7113
	f1	-338.33333*	15.31521	<.001	-387.3780	-289.2887
	f2	-90.33333*	15.31521	.002	-139.3780	-41.2887

*. The mean difference is significant at the 0.05 level.

The Tukey post-hoc test of pH values showed that F3 had the most significant difference compared to the other formulas. Meanwhile, F0 vs. F1 and F1 vs. F2 did not show significant differences ($p > 0.05$). The Tukey post-hoc test of dispersion power yielded a significance value of <0.001 for all formulas, indicating that they were significantly different from one another ($p < 0.05$), except for formula F1 vs. F2, which yielded a significance value of <0.0067, indicating that they were not significantly different.

The Tukey post-hoc test of adhesion strength yielded significant results. <0.001 for all formulas, indicating substantial differences between them ($p < 0.05$). Meanwhile, formulas F2 and F3 also showed minor differences in adhesive strength compared to other formulas, with significant results. 0.002 < 0.005.

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Discussion

Physical Quality Test Results

Organoleptic Test

Organoleptic testing is one of the physical evaluation methods for cleansing balm formulations, which involves directly observing the form, odor, and color of the formulation using the five senses. Based on Table 1, the results of the organoleptic testing on the cleansing balm formulations indicate that all formulations (formulas 0, 1, 2, and 3) have a semi-solid consistency formed from the combination of wax or waxy agents, vegetable fats, and oils. The texture of Formula 1 tends to be more complicated than that of the other formulations. The light green color in formulations 1, 2, and 3 is derived from the addition of pegagan extract at a concentration of 3% (3 g). Meanwhile, formulation 0 exhibits a pale or milky white color due to the absence of additional ingredients that serve as colorants, such as the green color imparted by Centella asiatica extract (Centella asiatica [L.] Urban). The odor test results indicate that all formulations have a characteristic lavender scent derived from the added lavender essential oil, which serves as a fragrance.

Homogeneity Test

Homogeneity testing was conducted to verify that the preparation was well-blended, incorporating the active ingredient with other additives. The results of the homogeneity test are presented in Table 2, which indicates that formulations 0, 1, 2, and 3 of the cleansing balm preparation did not contain any coarse particles visible to the naked eye after being applied to a glass object. This indicates that all particles are evenly dispersed and there is no agglomeration, thus concluding that each formulation is homogeneous in the cleansing balm formulation (Tungadi et al., 2023).

pH test

pH testing was conducted to measure the pH acidity level, which influences the formulation of cleansing balm (Sukoharjanti et al., 2024). A formulation with an appropriate pH level can maintain the physical and chemical stability of the product, thereby preventing skin irritation (Istiana et al., 2025). Based on Table 3, the average pH test results for the cleansing balm formulations were F0 = 5.57, F1 = 5.61, F2 = 5.65, and F3 = 5.72, indicating that all formulations meet the pH test criteria for topical formulations safe for the skin, which range from 4.5 to 6.5. A significant increase in pH occurred in each formulation, but all formulations remained within the safe range for skin (Suryani & Cahyaningsih, 2025).

Dispersion Test

Spreadability testing was conducted to determine the ability of the cleansing balm formulation to spread when applied to the skin, thereby assessing ease of application. A topical formulation with good spreadability indicates that the product spreads easily when applied to the skin surface, resulting in broader contact between the formulation and the skin, which allows active ingredients to be absorbed more quickly and optimally. (Lumentut et al., 2020). Based on Table 4, the average spreadability of each formula (F0, F1, F2, and F3) was 4.20 cm, 4.91 cm, 5.04 cm, and 5.50 cm. From these averages, it can be seen that formula 3 has the highest spreadability and formula 0 has the lowest. The test results indicate that the spreading ability increases with the increase in castor oil concentration in each formula. Castor oil has emollient properties, which function to soften the texture of the balm. Meanwhile, formula 0, which contains only coconut oil, has a more solid and hard consistency compared to other formulas,

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thereby reducing its spreading ability. Overall, the spreading ability test results in Table 4 indicate that all formulas (0, 1, 2, and 3) meet the spreading ability test criteria, ranging from 5 to 7 cm (Sukma Wibowo et al., 2024).

Adhesion Test

Adhesion testing was conducted to evaluate the duration of the formulation's ability to adhere to the skin. A semi-solid formulation exhibits good adhesion if it remains in contact for more than 4 seconds. Based on the adhesion test results shown in Table 5, the average adhesion values for each formulation are 6.35 seconds, 13.43 seconds, 10.95 seconds, and 10.09 seconds, indicating that all four formulations meet the required adhesion criteria. Formula 1 has the highest adhesion value compared to the other formulations. The adhesion test results decreased with decreasing castor oil concentration; therefore, Formula 0, with a 0% castor oil concentration, had the lowest adhesion compared to the other formulas.

Melting Point Test

Based on Table 6, it was found that the average melting points of each formula were F0 at 37.67 °C, F1 at 36.67 °C, F2 at 36 °C, and F3 at 36 °C. The results indicate that all formulas fall within the acceptable melting point range of 35–37 °C, consistent with skin temperature, ensuring they remain liquid when applied (Sukma Wibowo et al., 2024). Based on the test results, it can be concluded that the decrease in melting point temperature is consistent with the increase in castor oil content in each formula. This is consistent with the physical properties of pure coconut oil, which has a higher melting point, ranging from 24.5 to 25.5 °C, while castor oil remains liquid at low temperatures, ranging from -12 °C (Ummah, 2019).

The SPSS data analysis test was obtained from normality analysis using the Shapiro-Wilk test for each formula, indicating significance. The p-value was greater than 0.05, indicating that the data were normally distributed. The study was then continued with a homogeneity of variance test (Levene's Test) to determine whether the variances were identical or not. From the results of the homogeneity test, all sig. Values were greater than 0.05, indicating that the melting point data between the formulas had homogeneous variances, thus meeting the requirements to proceed with the One-Way ANOVA test. The ANOVA test was conducted to determine whether there were significant differences among the four formulas. From the results, it was found that the significance value of the melting points was significant. 0.500 > 0.001, indicating that there were no significant differences in the melting points of the four cleansing balm formulas. Therefore, no post-hoc test was necessary.

Clean Power Test

The cleanliness evaluation aims to determine the ability of cleansing balm formulations to remove and dissolve makeup or cosmetic residues (Kisno Saputri et al., 2022). The test results in Table 8 indicate that formula F1 achieves the best cleanliness, as it effectively removes nearly all mascara residues. Formula F2 is also quite effective, but still leaves a small amount of mascara residue. Formula F3 only partially cleansed, with mascara residue still clearly visible, compared to F2. Meanwhile, F0 had the lowest cleansing efficacy, leaving a significant amount of mascara residue. Based on the test results, it can be concluded that F1 demonstrates the best cleansing efficacy, while F3 shows a decrease in effectiveness despite having the highest castor oil content. Formula 0, which does not contain castor oil

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or pegagan extract, has the lowest cleaning power and leaves a greasy feeling after rinsing. Formula F1, with a 30% castor oil concentration and 3% pegagan extract, boasts the best cleaning power and leaves no greasy residue after rinsing with water, making it easy and comfortable to use. The combination of castor oil and coconut oil at balanced concentrations can enhance the cleaning power of the balm. Castor oil has more polar properties, which help prevent an oily residue after rinsing, while coconut oil, as a natural surfactant, exhibits good cleaning power (Sukma Wibowo et al., 2024).

Irritation Test

Irritation testing was conducted to evaluate the potential irritation caused by the cleansing balm formulation. The results of the irritation testing, as shown in Table 8, were performed on six respondents and did not reveal any signs of irritation, such as erythema or edema, in any of the four formulations at each observation time. The irritation test results for the cleansing balm showed an irritation index of 0 for all parameters, including erythema and edema, at 0, 24, 48, and 72 hours. These results indicate that all four formulas have excellent safety profiles and do not cause skin irritation during the testing period.

Data Analysis Results

Normality test

Normality tests were conducted to determine whether the data from a variable were usually distributed. In this study, normality tests were performed on the data obtained from pH values, spreadability, adhesion, and melting points for each formula. Based on the results of the Shapiro-Wilk normality test in Table 9, the sig value was greater than 0.05, indicating that the data from each value, namely pH, spreadability, adhesion, and melting point, were usually distributed.

Homogeneity test

Homogeneity tests were conducted to determine whether the variance between data groups was homogeneous (uniform). The test used was the Lavene Test with a significance value of $p>0.05$ for the data on pH values, spreadability, adhesion, and melting point for each formula. Based on the results in Table 10, the test indicates that the significance value (sig.) is greater than 0.05 for all parameters, meaning that the variance between the data groups is homogeneous. Therefore, the data for pH values, spreadability, adhesion, and melting point meet the criteria to proceed to the One-Way ANOVA test.

One-Way ANOVA Test

An ANOVA test was conducted to determine whether there were significant differences between the formulas. Based on Table 11, the significance values for pH, spreadability, and adhesion are <0.001, indicating significant differences between the formulas. However, the significance value for the melting point is significant. 0.500 > 0.001, indicating no significant differences in the melting point values among the four cleansing balm formulas.

Tukey post-hoc test

The Tukey post-hoc test is a follow-up test to the One-Way ANOVA, used to identify significant differences between treatment groups, provided that the conditions of normality and homogeneity tests are fulfilled. The results of the Tukey post-hoc test in several tests are as follows:

pH test

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The post-hoc test using the Tukey method is used to determine further differences between the formulation groups. The asterisk (*) indicates a significant difference in pH values between each formulation. From the analysis in Table 12, it is essential to note that <0.05 in several formulation groups, suggesting that there are significant differences between groups. However, in the F0 vs F1 and F1 vs F2 groups, the sig. The value was 0.084, which is greater than 0.05, indicating no significant difference. The means difference column indicates that F3 exhibits the most considerable pH difference compared to the other formulations. The highest pH increase occurred in F3, likely due to the highest castor oil concentration (40%) compared to different formulations. This is supported by previous research indicating that the pH of cleansing balm formulations decreases as the concentration of coconut oil added to the formulation increases (Sukma Wibowo et al., 2024).

Spread power test

Based on the results of the post-hoc Tukey test in Table 13, a significant difference was found. A <0.05 value was obtained for all formulation groups, indicating that there are substantial differences between the groups. However, only in the F1 vs. F2 formulation group was a significant difference observed. A value of 0.067 > 0.05 was obtained, indicating no significant difference, meaning both have nearly identical dispersion abilities. In Table 5, the "means difference" column shows that F3 has the highest dispersion ability, while F0 has the lowest dispersion ability. The test results indicate that dispersion ability increases with the increase in castor oil concentration in each formulation.

Adhesion test

The Tukey post-hoc test of adhesion strength, as shown in Table 14, yielded a significant result. Value <0.05 in all formulation groups, so it can be concluded that there are substantial differences between groups. The most considerable difference was observed between F1 and F0 with a significance level of <0.001. Additionally, formulas F2 and F3 showed minor differences in adhesion strength compared to other formulas, with significance levels of 0.002 < 0.005. The adhesion of F2 was higher than that of F3 by 90.33. Formula F1, with a castor oil concentration of 30%, was optimal for providing a good viscosity and sticky texture without making the balm too slippery, resulting in the longest adhesion time compared to other formulas. Conversely, F3, which has the highest castor oil concentration (40%), experienced a decrease in adhesion strength, likely due to the balm becoming too oily and slippery. Meanwhile, F0, which does not contain castor oil and uses only coconut oil, produces a balm that tends to be harder and less adhesive.

Conclusion

Based on the results of research conducted on cleansing balm preparations from Centella asiatica (L.) Urb. Extract with castor oil (Ricinus communis L.) as a base. The results of this study indicate that the physical quality evaluation of the cleansing balm formulation made from Centella asiatica (L.) Urb. Extracts with a concentration of 3% and castor oil (Ricinus communis L.) as a base, at concentrations of 30%, 35%, and 40%, meet all physical quality test requirements, including organoleptic testing, homogeneity testing, pH testing, spreadability testing, adhesion testing, and cleaning power testing. The most optimal formulation of the cleansing balm preparation from Centella asiatica extract (Centella asiatica (L.) Urb.) with a concentration of 3% and castor oil (Ricinus communis L.) as a base at concentrations of 30%, 35%, and 40% is formulation 1, which is effective with an active ingredient

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concentration of 3% Centella asiatica extract and 30% castor oil in all tests. The cleansing balm formulation from Centella asiatica extract at a concentration of 3% (Centella asiatica (L.) Urb.) with a castor oil (Ricinus communis L.) base at concentrations of 30%, 35%, and 40% demonstrated effectiveness as a makeup remover, as proven by the cleansing efficacy test, with Formula 1 showing the best cleansing and rinsing properties. The cleansing balm formulation containing 3% Centella asiatica (L.) Urb. Extract with a castor oil (Ricinus communis L.) base at concentrations of 30%, 35%, and 40% met safety criteria in irritation tests, with no irritation reactions reported by any of the 6 participants during the testing period.

A limitation of this study is the absence of an ethanol-free test, which means that it cannot be confirmed whether the formulation is genuinely free of residual ethanol, potentially affecting product safety. Long-term stability testing has not been conducted, so the formulation's resistance to physical changes (color, odor, and consistency) during storage cannot be determined. Hedonic testing has not been performed, so the formulation's comfort level, aroma, and texture, as perceived by consumers, are unknown.

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Corresponding author

Bintari Tri Sukoharjanti can be contacted at: bintaritri@umkudus.ac.id