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Formulation and Physical Evaluation of Liquid Shampoo Combining Patchouli Leaf Extract and Coconut Oil as an Antidandruff Shampoo

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ABSTRACT

Purpose: Dandruff is a scalp condition that affects approximately 50% of the global population and 26% of the population in Indonesia. This study aims to formulate and evaluate various formulations of liquid shampoo containing a combination of patchouli leaf extract (Pogostemon cablin Benth.) and coconut oil as an alternative natural-based anti-dandruff shampoo.

Research Method: This study used a quantitative approach with an experimental design. The formulation consisted of a combination of patchouli leaf extract at concentrations of 0.5%, 0.75%, and 1% and coconut oil at concentrations of 2%, 3%, and 4%. Quality evaluation was conducted through organoleptic testing, homogeneity testing, pH measurement, foam height measurement, viscosity measurement, and skin irritation testing on 15 respondents.

Results and Discussion: All formulas (F0, F1, F2, F3) meet the physical quality criteria for shampoo. Organoleptic testing indicates that the formula has a thick liquid consistency, is homogeneous, and ranges in color from clear to dark green, with a green tea aroma. The average pH is within the safe range (6.75–5.31). Foam height and viscosity are within normal limits, and no respondents reported any irritation complaints.

Implications: The formulation of liquid shampoo combining patchouli leaves and coconut oil can be a potential solution in the development of safe, natural-based anti-dandruff products. This study provides scientific contributions to the herbal cosmetics industry in Indonesia.

Keywords: liquid shampoo; patchouli leaves; coconut oil; physical evaluation test; irritation test.

Introduction

Pityriasis capitis, commonly referred to as dandruff, is one of the most common scalp disorders, significantly impacting an individual's quality of life. Dandruff is characterized by the presence of flakes or scales of white to gray skin that shed excessively on the scalp and spread to the hair shaft, accompanied by itching and occasionally mild inflammation (Putri *et al.*, 2021). Although it does not pose serious health risks, dandruff can cause aesthetic discomfort, social distress, and reduced self-confidence, making it a primary concern in scalp care. This condition can be triggered by various factors, such as the growth of the Malassezia fungus, dry scalp, excessive sebum production, stress, and

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reactions to certain hair care products (Putri *et al.,* 2021). This phenomenon is not a minor issue given its high prevalence. According to global data, dandruff affects approximately 50% of the world's population, typically appearing after puberty, with the highest incidence occurring around age 20. After the age of 50, its prevalence decreases significantly (Borda & Wikramanayake, 2015). In Indonesia, based on research conducted by the Ministry of Health of the Republic of Indonesia, approximately 26% of the population experiences dandruff (Ministry of Health of the Republic of Indonesia, 2022). The 15–24 age group is the most vulnerable to this condition (Prayogo *et al.,* 2024). The prevalence of dandruff also varies among ethnic groups, indicating that genetic differences, climate, and hair care habits contribute to the occurrence of dandruff. Although many anti-dandruff shampoos are available on the market, their effectiveness and safety are often questioned, particularly due to the use of synthetic chemicals that can have adverse effects on the scalp and the environment (Putri *et al.,* 2021).

In recent years, increased consumer awareness of the long-term effects of synthetic chemicals in personal care products has driven a shift in preference toward natural products. Shampoo, as the most commonly used hair care product, now serves not only to clean the scalp of dirt, sebum, and product residue but also to provide additional benefits such as addressing dandruff, maintaining scalp moisture, and improving overall hair condition (Bartkutė, 2024). One natural ingredient that is gaining attention in shampoo formulations is patchouli (Pogostemon cablin Benth). This plant has been widely cultivated in Indonesia for over a century and is a leading export commodity used in various industries, including pharmaceuticals, food, perfumes, soaps, and cosmetics (Cano-Reinoso *et al.,* 2021). The active compounds in patchouli leaves, such as patchouli alcohol, sesquiterpenes, and anti-inflammatory compounds, have significant potential in addressing dandruff due to their antimicrobial and antifungal properties, which can inhibit the growth of Malassezia, the primary cause of dandruff (Setiaji & Prayugo, 2006). Additionally, patchouli leaves contain flavonoids, tannins, and alkaloids that are beneficial for maintaining a healthy scalp. On the other hand, Virgin Coconut Oil (VCO), which contains lauric acid, vitamin K, vitamin E, and iron, has been traditionally and scientifically proven to be effective in promoting hair growth, treating dandruff, and providing moisturizing and protective effects against hair damage (Rosalina, 2023; Setiaji & Prayugo, 2006). Research by Anggraeni *et al.,* (2020) also showed that nilam oil is effective against Staphylococcus aureus ATCC 25923.

Although various studies have investigated the effectiveness of patchouli leaf extract and coconut oil separately in skin and hair care product formulations, there is a significant gap in empirical studies integrating both ingredients into a single liquid shampoo formulation, particularly as an anti-dandruff agent. Most previous studies have focused solely on the antibacterial, antifungal, or moisturizing properties of each ingredient without exploring their synergistic effects in a ready-to-use topical formulation. These studies generally employ in vitro methods and do not include comprehensive evaluations of physical parameters such as pH, viscosity, moisture content, yield, and organoleptic aspects, which are critical determinants of product quality and market acceptance. However, these physicochemical aspects are crucial for developing effective and commercially viable shampoos. For example, research by Hafyyan *et al.,* (2024) successfully formulated a shampoo with a 1% concentration of nilam oil and demonstrated that the formulation met quality standards according to SNI Sampo 06-2692-1992. However, this study did not test the integration of coconut oil as an additional active ingredient known for its anti-dandruff and hair-protective properties. The absence of a comprehensive approach in this combination formulation indicates a research gap that remains unaddressed both theoretically and practically. Therefore, an experimental study is needed to systematically develop and evaluate the combination formulation of nilam leaf extract and coconut oil in liquid shampoo

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formulations as an innovative effort to address consumer demand for natural, effective, and safe anti-dandruff products.

The novelty and uniqueness of this study lie in attempting to integrate two potential natural ingredients, namely lemongrass leaf extract and coconut oil, into a specially designed liquid shampoo formulation as an anti-dandruff agent. This innovation was achieved by designing variations in the concentration of lemongrass leaf extract at 0.5%, 0.75%, and 1%, and coconut oil at 2%, 3%, and 4%. This allowed for the testing of the synergistic effectiveness of both ingredients in a single formulation. Another novelty is the comprehensive evaluation approach to the formulation's physical quality, which includes pH, moisture content, organoleptic properties, and yield as quality indicators, by national standards. In addition to addressing dandruff, this formulation is also expected to provide several additional benefits, including soothing irritation, strengthening hair shafts, maintaining scalp moisture, and protecting hair from UV exposure and damage caused by harmful chemicals. The primary objective of this study is to formulate and evaluate a liquid shampoo containing a combination of nilam leaf extract and coconut oil that is effective as an anti-dandruff agent and safe for topical use. This study is expected to contribute to the development of natural-based cosmetic formulations that are not only clinically effective but also align with principles of sustainability and environmental friendliness. As such, the results of this research have the potential to serve as a reference to produce modern herbal shampoos that meet consumer demands for healthy, high-quality, and highly effective products.

Literature Review and Hypothesis Development

Patchouli leaf extract (Pogostemon cablin)

Patchouli leaf extract (Pogostemon cablin Benth.) is a processed product derived from the leaves of the patchouli plant, which is known to be rich in essential oils and bioactive compounds, particularly patchouli alcohol. This plant has been widely used in the perfume, pharmaceutical, and cosmetic industries due to its multifunctional properties, including as a fragrance, antimicrobial, and anti-inflammatory agent (Jeong *et al.,* 2013). Patchouli alcohol is the primary compound in patchouli oil, with a concentration that can exceed 30% of the total active chemical composition. In addition to patchouli alcohol, patchouli leaf extract also contains other compounds, such as sesquiterpenes (guaiene, seychellene), flavonoids, tannins, and alkaloids, each with its unique biological functions. According to Fan *et al.,* (2023), patchouli alcohol exhibits inhibitory effects on viral replication and possesses significant immunomodulatory properties. Sesquiterpenes, as explained by Su *et al.,* (2016), contribute to antimicrobial activity and protection against oxidative stress. The flavonoids and tannins contained in the extract also act as powerful antioxidants and natural anti-inflammatories that support scalp health, particularly in alleviating irritation and mild inflammation caused by fungal or bacterial infections.

Functionally, patchouli leaf extract exhibits high potential as an anti-dandruff agent due to its antimicrobial and anti-fungal properties. Patchouli alcohol is effective against various microorganisms that cause infections, including Malassezia spp., which is recognized as the primary cause of dandruff in humans (Wan *et al.,* 2021). Research by Feng *et al.,* (2014) demonstrated that patchouli alcohol can inhibit skin damage caused by UV exposure and promote skin tissue repair through anti-inflammatory mechanisms. On the other hand, a study by Jeong *et al.,* (2013) also highlighted the compound's ability to reduce the expression of inflammatory mediators, such as TNF-α and IL-6, in RAW264.7 macrophages. This indicates that, in addition to its antimicrobial properties, patchouli alcohol also

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contributes to the healing process of inflammation. With its ability to reduce fungal growth and alleviate inflammation, patchouli leaf extract emerges as a promising natural active ingredient candidate for use in safe and effective anti-dandruff shampoo formulations. This advantage is further reinforced by the presence of sesquiterpenes and flavonoids, which not only help inhibit microbes but also maintain the natural oil balance of the scalp, thereby reducing the risk of irritation caused by dry or excessively oily scalp (Xie *et al.,* 2016).

The use of nilam leaf extract in topical and cosmetic formulations has been extensively studied in various research studies. In the cosmetic industry, nilam oil is used not only for its distinctive and long-lasting aroma but also for its ability to naturally care for the skin and hair (Aswandi *et al.,* 2024). A study by Anggraeni *et al.,* (2020) demonstrated that the addition of patchouli oil to liquid soap has a significant antibacterial effect against Staphylococcus aureus, a pathogenic bacterium commonly found on the skin. Additionally, research by Jeong *et al.,* (2013) on human colorectal cancer cells demonstrated promising antitumor activity from patchouli alcohol, indicating its potential as an active therapeutic ingredient in topical formulations. In shampoo formulations, patchouli leaf extract provides additional benefits, including good organoleptic properties such as a soothing aroma, natural color, and high chemical stability, making it a suitable ingredient for modern herbal cosmetics. In more complex formulations, the integration of patchouli leaf extract with other natural ingredients such as coconut oil is believed to provide synergistic effects in hair care, dandruff control, and maintaining the balance of scalp microflora.

Coconut oil (Virgin Coconut Oil)

Virgin coconut oil (VCO) is a vegetable oil extracted from fresh coconut meat without undergoing high-temperature heating or chemical purification, thereby preserving its nutritional content optimally (Ng *et al.,* 2021). The uniqueness of VCO compared to regular coconut oil lies in its higher content of bioactive compounds, particularly lauric acid, which naturally constitutes approximately 40–50% of the total fatty acid composition in VCO. Lauric acid is recognized for its potent antimicrobial activity, with numerous studies demonstrating its ability to inhibit the growth of pathogenic microorganisms, including bacteria and fungi commonly found on the scalp (Narayanankutty *et al.,* 2018). Additionally, VCO contains vitamins E and K, as well as minerals such as iron and zinc, which support scalp cell regeneration and improve blood flow around hair follicles, making it a potential ingredient in cosmetic formulations for scalp and hair care (Barve & Dighe, 2016). Kim & Ahn, (2023) emphasize that the medium-chain structure of fatty acids in VCO allows it to penetrate hair shafts more effectively than long-chain oils, providing deeper protection and nourishment. In addition to serving as a nutrient source, VCO plays a crucial functional role in hair care due to its moisturizing, anti-inflammatory, and anti-dandruff properties. The moisturizing effect of VCO stems from its ability to form a protective layer on the scalp and hair shaft, thereby reducing transepidermal water loss and maintaining skin moisture (Varma *et al.,* 2019). With maintained moisture, the scalp becomes less prone to flaking, which is one of the leading causes of dandruff. Furthermore, the lauric and capric acids in VCO act as anti-inflammatory agents, suppressing the production of pro-inflammatory cytokines such as TNF-α and IL-6, thereby reducing inflammation in the sensitive or irritated scalp (Elshall *et al.,* 2022). In the context of dandruff, often caused by fungal infections such as Malassezia furfur, the antifungal activity of VCO provides additional benefits in inhibiting the colonization of these microorganisms

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without causing the irritation commonly associated with synthetic chemical-based anti-dandruff products (Suryani *et al.,* 2020).

Therefore, VCO not only acts as a natural moisturizer but also as a healing and protective agent that supports overall scalp health. The effectiveness of coconut oil in hair care has been proven through various experimental and clinical studies. Kim & Ahn, (2023) found that VCO has better penetration into the hair shaft compared to mineral oil, making it superior in strengthening hair structure from within. Additionally, regular use of VCO can enhance hair shine, reduce damage from heat exposure, and improve the texture of dry and damaged hair (Gondokesumo *et al.,* 2023). In cosmetic applications, Barve & Dighe, (2016) explain that VCO is chemically stable and resistant to oxidation, making it suitable for formulation in herbal shampoos targeted at consumers with sensitive scalps. Tagle (2018) also developed an automated extraction technology for VCO to preserve the quality of active compounds in large quantities and efficiently on an industrial scale, supporting its use in the large-scale production of hair care products. Further research by Ng *et al.,* (2021) confirms that cold processing methods for VCO can preserve the molecular structure of fatty acids and vitamins intact, thereby providing maximum benefits when applied to the skin and hair.

Liquid shampoo (formulation)

Liquid shampoo is a topical cosmetic preparation that cleanses the scalp and hair of dirt, oil, dead skin cells, and residues from other products by emulsifying them using surfactants (Krunali *et al.,* 2013). In addition to its basic cleansing function, modern liquid shampoo is formulated to provide various benefits, including strengthening hair, maintaining moisture, addressing dandruff, and delivering desired cosmetic effects. The general formulation of liquid shampoo consists of base ingredients, including water, primary and secondary surfactants, thickeners, humectants, active ingredients (such as antimicrobial agents or moisturizers), preservatives, colorants, and fragrances. The success of a formulation is not only determined by the effectiveness of the active ingredients, but also by the physical stability of the preparation and its comfort during use, including its foaming ability, viscosity, and consumer-preferred odor (Žlabienė *et al.,* 2024). A good shampoo should provide optimal cleansing effects without causing irritation or disrupting the scalp's balance. Therefore, the selection and combination of ingredients in shampoo formulations must be carefully designed and meet the established cosmetic quality criteria.

As a form of cosmetic product quality regulation in Indonesia, the National Standardization Agency (BSN) has established the SNI 06-2692-1992 standard as a reference for assessing the quality of liquid shampoo. This standard encompasses both functional parameters, such as foam and cleaning power, and physical parameters, including pH, water content, viscosity, yield, and organoleptic evaluation (color, odor, and texture) (Fauziyah *et al.,* 2020). pH is a crucial component in formulation as it directly relates to the comfort and safety of the user's scalp. According to research by Varma *et al.,* (2019), the human scalp has a natural pH range of 4.5 to 5.5. Therefore, an ideal shampoo should be formulated within a pH range of 4.5–7 to avoid damaging the protective layer of the skin and the normal flora on the scalp surface. A pH that is too low can irritate the skin, while a pH that is too high tends to dry it out and make hair more prone to breakage. In addition to pH, the water content in the formulation must also be carefully controlled. Fatimah *et al.,* (2016) explains that optimal water content helps maintain the formulation's viscosity and reduces the risk of microbial contamination.

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Formulations with excessive water content tend to be unstable and more prone to degradation. At the same time, formulations with too low water content can cause the product to become too thick and difficult to use. Yield is also an important indicator in evaluating shampoo formulations, particularly in production processes that span from the laboratory to the industrial scale. High yield indicates efficiency in the formulation and mixing process, with minimal loss or degradation of active ingredients (Anggraeni *et al.,* 2020). In a study comparing shampoo formulations with various natural active ingredients, yield was used as a parameter to determine the best formulation in terms of stability, ingredient solubility, and mixing efficiency. Ng et al. (2021) emphasized that high yield in herbal topical preparations is an indicator of successful formulation that can be developed sustainably in the modern cosmetics industry. A similar point was made by Suryani *et al.,* (2020), who found that cosmetic formulations meeting physical stability parameters and achieving a good production yield are more likely to progress to the commercialization stage. Considering all these parameters, both functional and physicochemical, the development of high-quality liquid shampoo must adhere to established scientific standards and regulations, ensuring that the final product is not only practical but also safe and meets consumer preferences.

Research Method

This study used a quantitative approach with an experimental design. An experimental design was chosen because it allows researchers to design and evaluate the effects of combining patchouli leaf extract (Pogostemon cablin Benth.) and coconut oil in a liquid shampoo formulation on physical parameters and skin irritation potential. The objective of this study is to determine the formulation results and physical evaluation of the liquid shampoo formulation developed as a natural-based anti-dandruff shampoo. The formulation process and physical testing of the formulation were conducted at the ITEKES Cendekia Utama Kudus Laboratory. In contrast, the skin irritation testing was carried out at the University of Muhammadiyah Kudus. The population in this study consisted of two types: the natural ingredient population and the test respondent population. The natural ingredient population includes patchouli leaves (Pogostemon cablin Benth.) and coconut oil. Patchouli leaves (3 kg) were obtained from Air Baru Village, Runjung Agung Subdistrict, Ogan Komering Ulu Selatan District, South Sumatra Province, while coconut oil (1 liter) was obtained from PT. Dari Bumi Nusantara. The sample material used in the formulation was 250 grams of patchouli leaves, extracted using 96% ethanol with a solvent ratio of 1:10, by SNI 06-2385-2006, which addresses the solubility of patchouli oil in alcohol. The sample for the skin irritation test consisted of 15 volunteers aged 20–25 years from the student population of Muhammadiyah University of Kudus.

The data collection techniques employed in this study utilized a systematic and structured direct observation method. Observations were used to observe and record the results of the liquid shampoo formulation, including physical parameters such as pH, viscosity, water content, yield, and organoleptic evaluation. Additionally, observations were conducted on the skin reactions of participants after the irritation test to assess the safety of the formulation on the skin. The instruments used included standard laboratory equipment for physical testing of the formulation, as well as observation sheets to record the results of evaluations for each physical parameter and the irritation test results. Data obtained from the formulation and physical evaluation of the formulation were analyzed using the Statistical Package for the Social Sciences (SPSS) software. The statistical test used was One-Way Analysis of Variance (ANOVA) to determine significant differences between shampoo formula groups based on the specified physical

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test parameters. ANOVA was chosen because it is suitable for comparing the means of three or more different treatment groups. Statistical test results were used to determine the most effective formula in terms of effectiveness and physical stability, as well as to ensure that the shampoo formulations produced met the established quality criteria.

Results and Discussion

Analysis Result

Table 1. Organoleptic Test Results

Observation on day-	Liquid shampoo preparation	Observation		
		Shape	Color	Smell
1	F0	Thick liquid	Clear	Special green tea oil
	F1	Thick liquid	Dark green	Special green tea oil
	F2	Thick liquid	Dark green	Special green tea oil
	F3	Thick liquid	Dark green	Special green tea oil
7	F0	Thick liquid	Clear	Special green tea oil
	F1	Thick liquid	Dark green	Special green tea oil
	F2	Thick liquid	Dark green	Special green tea oil
	F3	Thick liquid	Dark green	Special green tea oil

Table 2. Homogeneity Test Results

Liquid shampoo preparation	Observation on day-		Description
	1	7	
F0	Homogen	Homogen	Eligible
F1	Homogen	Homogen	Eligible
F2	Homogen	Homogen	Eligible
F3	Homogen	Homogen	Eligible
The test preparation should be homogeneous and free from visible spots. (Hasriyani *et al.*, 2021)			

Based on Table 2, all formulation designs meet the homogeneity test requirements.

Table 3. pH Test Results

Liquid shampoo preparation	Replication			Average	Description
	1	2	3		
F0	6.77	6.76	6.74	6.75	Eligible
F1	5.65	5.64	5.63	5.64	Eligible
F2	5.50	5.52	5.51	5.51	Eligible
F3	5.30	5.32	5.31	5.31	Eligible
The pH of liquid shampoo preparations ranges from 5.0 to 9.0 (BSN, 1992).					

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Table 4. Foam Height Test Results

Liquid shampoo preparation	Minute			Description
	1 (cm)	5 (cm)	7 (cm)	
F0	17	16	15	Eligible
F1	22	18	17	Eligible
F2	19	18	17	Eligible
F3	20	19	18	Eligible
The foam height requirement is between 1.3 and 22 cm (Lestari *et al.,* 2021)				

Table 5. Viscosity Test Results

Liquid shampoo preparation	Replication			Average	Description
	1	2	3		
F0	607	612	656	625	Eligible
F1	405	430	522	452.3	Eligible
F2	539	541	555	545	Eligible
F3	502	512	530	514.6	Eligible
The viscosity test requirement is between 400 and 4000 cPs. (BSN, 1992)					

Table 6. Irritation Test Results

Types of Irritation	Statement	Volunteer														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
F0	Itching	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Redness	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Swelling	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	No complaints	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
F1	Itching	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Redness	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Swelling	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	No complaints	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
F2	Itching	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Redness	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Swelling	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	No complaints	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
F3	Itching	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Redness	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Swelling	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	No complaints	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

Based on Table 3, the pH test results for liquid shampoo preparations, on average in F0, F1, F2, and F3, meet the requirements for a good shampoo pH according to the National Standardization Agency. Based on Table 4, the foam height test results for F0, F1, F2, and F3 meet the requirements for

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good foam height. Based on Table 5, the viscosity test results show that all formulations meet the requirements for good viscosity values. Based on Table 6, the results of the irritation test on all shampoo formulas (F0, F1, F2, and F3) showed that no skin irritation reactions, such as itching, redness, or swelling, were observed in any of the respondents. All participants reported no complaints either during or after the irritation test, indicating that all four shampoo formulas are safe for use on the skin.

SPSS test results

Normality tests are used to check whether data follows a normal distribution. The following are the results of normality tests using the Shapiro-Wilk test with a significance value greater than 0.05. The results of the normality tests for pH, foam height, and viscosity values are presented in Table 7.

Table 7. Normality Test Analysis

Treatment		Shapiro-Wilk			Description
		Statistics	Replikation	Signicance	
pH value	F0	.964	3	0.637	Normally Distributed Data
	F1	1.000	3	1.000	
	F2	1.000	3	1.000	
	F3	1.000	3	1.000	
High Foam Value	F0	1.000	3	1.000	Normally Distributed Data
	F1	.893	3	0.363	
	F2	1.000	3	1.000	
	F3	1.000	3	1.000	
Viscosity Value	F0	.826	3	0.177	Normally Distributed Data
	F1	.901	3	0.390	
	F2	.842	3	0.220	
	F3	.974	3	0.688	
The significance value requirement is p < 0.05.					

Based on Table 7, the normality test results indicate that the pH, foam height, and viscosity data in all formulas (F0, F1, F2, and F3) are typically distributed, as the significance values in each test are greater than 0.05. Thus, all parameters meet the normality assumptions required for further statistical analysis.

homogeneity

Table 8. Homogeneity Test Analysis

Homogeneity	Levene Statistic	Significance	Description
pH value	.400	0.757	Homogeneous Distributed Data
High Foam Value	2.667	0.119	Homogeneous Distributed Data
Viscosity Value	5.530	0.024	Distributed Data is Not Homogeneous
Requirements for the Levene Statistic test with a significance value of >0.05			

The homogeneity test is used to determine whether the variance between different data groups is equal. This test is crucial to ensure that data from different groups can be compared fairly, assuming

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the same variance. If the variance is not homogeneous, the analysis method used needs to be adjusted. The following are the results of the normality test using the Levene Statistic test with a significance value greater than 0.05.

The results of the homogeneity test indicate that the pH value data (p = 0.757) and foam height data (p = 0.119) have significance values greater than 0.05, thus concluding that the data from both parameters are distributed homogeneously. Meanwhile, for viscosity values, a significance level of 0.024 was obtained, which is less than 0.05, indicating that the data are not homogeneously distributed. Therefore, for the non-homogeneous viscosity data, the analysis was continued using the Brown-Forsythe test, and the appropriate follow-up test is the Post-Hoc Games-Howell test.

Brown-Forsythe

Table 9. Brown-Forsythe Test Analysis of Viscosity Values

Viscosity Value	Total treatment group	Significance	Description
Based on Viscosity Value	4	0.030	There are significant differences between each group.
Brown-Forsythe test requirement with a significance value of <0.05			

Based on Table 9, it can be concluded that formulas 0, 1, 2, and 3 exhibit significant differences within each group, as determined by the Brown-Forsythe test significance requirement, specifically p < 0.05.

One Way ANOVA

One-way ANOVA test is used to compare the means of three or more independent (unpaired) groups to determine whether there are statistically significant differences between the groups.

Table 10. One-Way ANOVA Test Analysis

Value	Total treatment group	Significance	Description
pH Value Based on Viscosity Value	4	<0.001	There are significant differences between each group.
High Foam Value Based on Viscosity Value	4	0.143	There were no significant differences between the groups.
Requirements for the One-Way ANOVA test with a significance value of <0.05			

The results of the one-way ANOVA test indicate that for parameters with a significance level of less than 0.05, there are significant differences between Formulas 0, 1, 2, and 3, allowing for post-hoc testing to proceed. Meanwhile, for parameters with a significance level greater than 0.05, there are no significant differences between the formulas, so no further testing is required.

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Post Hoc Bonferroni

The Bonferroni Post Hoc test is a follow-up test to the One-Way ANOVA, used to identify significant differences between treatment groups, provided that the normality and homogeneity tests are satisfied. Based on Table 11, the results of the multiple comparison test using the Bonferroni method, with the dependent variable PH, indicate that overall, all comparisons between the groups show significant differences at the 0.05 level, by the significance level (Sig.). A value of less than 0.05 was observed in each comparison.

Table 11. Post Hoc Bonferroni Test Analysis of pH Values

Post Hoc Test	(I) Treatment	(J) Treatment	Significance
Bunferroni	F0	F1	<0.001
		F2	<0.001
		F3	<0.001
	F1	F0	<0.001
		F2	<0.001
		F3	<0.001
	F2	F0	<0.001
		F1	<0.001
		F3	<0.001
	F3	F0	<0.001
		F1	<0.001
		F2	<0.001
Significant difference in average at the 0.05 level			

Uji Post Hoc Gomes Howell

The Gomes Howell Post Hoc test is a follow-up test to the Brown-Forsythe test, used to identify significant differences between treatment groups, provided that the normality test is satisfied and the homogeneity of variance test is not satisfied. The results of the Gomes-Howell post hoc test for viscosity values are presented in Table 12.

Table 12. Post Hoc Gomes Howell Test Analysis of Viscosity Values

Post Hoc Test	(I) Treatment	(J) Treatment	Significance
Gomes Howell	F0	F1	0.072
		F2	0.071
		F3	0.024
	F1	F0	0.072
		F2	0.278
		F3	0.480
	F2	F0	0.071
		F1	0.278
		F3	0.130
	F3	F0	0.024
		F1	0.480
		F2	0.130
Significant difference in average at the 0.05 level			

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Based on Table 12, overall, significant differences were only found between F0 and F3 and F3 and F0, which had Sig. Values less than 0.05. All other comparisons showed no significant differences.

Discussion

Physical evaluation test

The following process is the physical evaluation test stage, which establishes standards for a high-quality liquid shampoo. The physical evaluation tests conducted include organoleptic tests, homogeneity tests, pH tests, foam height tests, and viscosity tests. The following are the results of the physical evaluation tests that have been conducted:

Organoleptic test

Organoleptic testing is one of the physical evaluation tests for shampoo preparations, aimed at directly observing the form, odor, color, and taste of the preparation. Organoleptic testing is an evaluation method that involves the human senses as the primary measurement tools. This method is often considered subjective because it depends on the individual assessment of each panelist. The parameters evaluated by the panelists include color, aroma, texture, and the absence of sediment. (Hafyyan *et al.,* 2024). Based on the results of the organoleptic test, Formula 0 has a transparent color, neutral aroma, green tea scent, a slight raw material odor or neutral odor, a bland taste, and a thick liquid texture. Formula 1 has a slightly darker/lighter color than Formula 0 due to the addition of active ingredients, a noticeable green tea aroma, a slightly more bland taste, and a thick liquid texture. Formula 2 has a more intense color than Formula 1, with a darker green hue, a stronger green tea aroma, a bland taste, and a smoother texture, resulting in a thick liquid. Formula 3 has the most striking color among the others, a dark green hue, a powerful and distinctive green tea aroma, a bland taste, and a thick liquid texture.

Homogeneity test

Homogeneity testing aims to assess the uniformity of component distribution in a formula, both visually, in terms of texture, and consistency. Homogeneity testing, as conducted by Hasriyani et al. (2021), involved evenly and thinly applying 0.1 grams to a glass slide. The test sample should show homogeneous arrangement and no visible spots. This is consistent with the results of the homogeneity test of liquid shampoo formulations, which showed that all four formulations were homogeneous, as no spots were observed. The results of the homogeneity test for the preparations are presented in Table 2. Formula 0, after being applied to the glass slide, appeared uniform without any separated particles or sediments. The color was uniform throughout, the texture was consistent and stable, with no lumps or separated phases observed. When stirred or touched, no coarse particles or oily layers were found. The conclusion is that homogeneity is perfect because no modifications were made to the additional ingredients. Formula 1, after being applied to the glass, appears generally uniform, but may show slight color differences or fine particles due to the addition of new ingredients. The texture remains smooth. The conclusion is that it tends to be homogeneous but requires optimization to improve stability. Formula 2, when applied to the visual glass, is generally uniform but shows color differences or fine particles due to the addition of more active ingredients compared to Formula 1. The texture remains smooth, and the conclusion is homogeneous. Formula 3, when applied to the visual glass, appears generally uniform, with noticeable color differences compared to the previous formula due to the

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addition of the highest amount of active ingredients. The texture remains smooth, and the overall conclusion is homogeneous.

pH test

pH testing is one of the most important aspects in maintaining the quality of shampoo. Shampoo with the appropriate pH level can improve hair quality and prevent scalp irritation. pH testing in shampoo aims to determine the safety and quality of the shampoo formulation (Hafyyan *et al.,* 2024). pH testing is conducted to measure the acidity or alkalinity of a formulation, which can affect product stability, safety, and acceptance. The following is an objective description of the pH test results for four formulas (0, 1, 2, and 3): Formula 0 yielded pH values of 6.77, 6.76, and 6.74 after three replicates, resulting in an average pH of 6.75 for Formula 0. Formula 1, based on three replicates, yielded an average pH of 5.64. Formula 2, based on three replications, yielded an average pH value of 5.51. Formula 3, with three replications, resulted in an average pH of 5.31. In the book Cosmetic Science and Technology: Theoretical Principles and Applications by Sakamoto et al. (2017), neutral pH is not ideal for shampoo because it is ineffective at removing sebum (optimal pH 5.5–6.9) and can cause hair cuticle swelling. The liquid shampoo formulation, based on objective observations, meets the pH requirements for good shampoo, which is consistent with SNI standards, where pH ranges from 5.0 to 9.0.

High foam test

Foam height testing is conducted to measure the foam-forming ability and foam stability of a formula, which is crucial in products such as soap, shampoo, cleansers, or foaming food and beverages. The following are the objective results of the foam height test on four formulas. Formula 0 produced a foam height 17 cm lower than the other formulas, which was due to the absence of the active ingredient nilam leaf extract, which naturally contains saponins. Formula 1 produced foam as high as 22 cm, influenced by the addition of the active ingredients nilam leaf extract and coconut oil, which naturally contain saponins. Formula 2, based on foam height observations, reached 19 cm, influenced by the active ingredients from the nilam leaf extract and coconut oil. Formula 3 had a foam volume of 20 cm, influenced by the active ingredients from the nilam leaf extract and coconut oil. Based on observations, after 5 minutes, the formulations of all four were sufficiently stable at 16 cm, 18 cm, 18 cm, and 19 cm, respectively. After 7 minutes, the form of all four formulations was sufficiently stable at 15 cm, 17 cm, 17 cm, and 18 cm, respectively. According to the literature, the foam height requirement ranges from 1.3 cm to 22 cm (Lestari *et al.,* 2021), indicating that the liquid shampoo formulation in this study meets the criteria for good foam height.

Viscosity test

Viscosity testing is conducted to measure the thickness (flow resistance) of a formula, which affects the stability, application, and user experience of a product. The following are the objective results of viscosity tests on four formulas. Formula 0 yielded viscosity values with three replicates, with the first replicate producing a viscosity of 607 cP, the second replicate producing a viscosity of 612 cP, and the third replicate producing a viscosity of 656 cP. The average viscosity for Formula 0 is 625 cPs. Formula 1 produced each replication with a viscosity of 405 cPs, 430 cPs, and 522 cPs, with an average viscosity of 452.3 cPs. Next, the viscosity of formula 2 with three replicas was 539 cPs, 541 cPs, and 555 cPs, with an average viscosity value of 545.6 cPs. Formula 3 yielded viscosity values of 502 cP, 512 cP, and 530 cP,

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based on three replications, with an average viscosity value of 514.6 cP. Based on observations, all four formulas met the requirements for good viscosity testing according to the standards set by the National Standards Institute (SNI). However, the viscosity of F3 decreased compared to the previous formula. This is likely due to the insufficient amount of thickening agents in the formula, resulting in a low viscosity. The shampoo formulation should contain more than one thickening agent. Another factor affecting viscosity is temperature. At high temperatures, viscosity decreases, meaning that viscosity is inversely proportional to temperature. This is because at high temperatures, particles in shampoo formulation tend to separate and fail to form a more compact bond structure, resulting in reduced shampoo viscosity.

Irritation test

Formula 0

The irritation test results for formula 0 showed that 0 out of 15 respondents reported irritation complaints (itching, redness, or swelling), and no significant changes were observed on the skin after application. This is attributed to the selection of minimally irritating ingredients used in the shampoo formulation in this study. The formulation is inert or very mild as it does not contain active ingredients or potential irritants. Formula 0 is safe based on this irritation test.

Formula 1

The irritation test results for formula 1 showed that 0 out of 15 respondents reported experiencing irritation, and the skin remained normal without any adverse reactions. Formula 1 is safe to use because it contains active ingredients in low concentrations and ingredients that have been tested for safety.

Formula 2

The irritation test results for formula 2 showed that 0 out of 15 respondents exhibited irritation symptoms. Some respondents reported normal sensations such as coolness or dryness, but these did not cause discomfort. Formula 2 contains active ingredients at moderate concentrations, which are more active than those in formula one but do not cause adverse reactions.

Formula 3

The irritation test results for formula 3 showed that 0 out of 15 respondents experienced irritation, with no reports of burning, itching, or redness. Formula 3, with the highest concentration of active ingredients based on this test, is safe for use.

Normality test

Normality testing is a statistical procedure used to test whether the data obtained follows a normal distribution. Data normality is essential because some statistical tests, such as parametric tests, assume that the data used is normally distributed. This test can be performed using various methods, such as the Shapiro-Wilk test with a significance level of $p > 0.05$. The results of the normality test table indicate that the pH values, foam height values, and viscosity values are normally distributed.

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Homogeneity test

The homogeneity test is a statistical test used to check whether several groups of data have the same variance (homogeneous) or not. This test is crucial as an assumption in several statistical analyses, such as Analysis of Variance (ANOVA). The type of test used is the Levene test with a significance value of p greater than 0.05. Based on the homogeneity test table, the pH values and foam height values are normally distributed, while the viscosity values are not normally distributed. Therefore, after the ANOVA test, a post-hoc Gomes Howell test is conducted.

Uji One Way ANOVA

The One-Way ANOVA test aims to test whether there are statistically significant differences in the mean between three or more independent groups. The requirement for the One-Way ANOVA test is that the significance level (p) is less than 0.05. According to the results of the pH value and foam height value tests, the significance levels are less than 0.001 and 0.143, respectively.

Bonferroni Post Hoc Test

The Bonferroni test is one of the post hoc methods used after a One-Way ANOVA shows significant results ($p < 0.05$). Its purpose is to identify which pairs of groups are truly statistically different. The following results can be observed:

- F0 and F1: There is a significant difference between F0 and F1 with a p-value less than 0.001, indicating that the mean difference between F0 and F1 is 111.667 with a 95% confidence interval between 108.387 and 114.946.
- F0 and F2: The difference between F0 and F2 is also significant with a p-value less than 0.001, with a mean difference of 124.667, and a 95% confidence interval between 121.387 and 127.946.
- F0 and F3: Significant differences were also observed between F0 and F3, with a mean difference of 144.667 and a 95% confidence interval between 141.387 and 147.946.
- F1 and F0: The test shows a significant difference between F1 and F0 with a mean difference of -111.667 and a 95% confidence interval between -114.946 and -108.367.
- F1 and F2: There is a significant difference between F1 and F2 with a mean difference of 13,000 and a 95% confidence interval between 9,7201 and 16,2799.
- F1 and F3: Significant differences between F1 and F3 were also found with a mean difference of 33,000 and a 95% confidence interval between 29,7201 and 36,2799.
- F2 and F0: There is a significant difference between F2 and F0 with a mean difference of -124.667 and a 95% confidence interval between -127.946 and -121.3867.
- F2 and F1: There is a significant difference between F2 and F1 with a mean difference of -13,000 and a 95% confidence interval between -16,2799 and -9,7201.
- F2 and F3: There is also a significant difference between F2 and F3, with a mean difference of 20,000 and a 95% confidence interval between 16,7201 and 23,2799.
- F3 and F0: There is a significant difference between F3 and F0 with a mean difference of -144.667 and a 95% confidence interval between -147.946 and -141.3867.
- F3 and F1: There is a significant difference between F3 and F1 with a mean difference of -33,000 and a 95% confidence interval between -36,2799 and -29,7201.
- F3 and F2: Finally, a significant difference was found between F3 and F2 with a mean difference of -20,000 and a 95% confidence interval between -23.2799 and -16.7201.

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Post Hoc Test for Howell's Game

The Gomes Howell post hoc test is a follow-up test to the Brown-Forsythe test, used to identify significant differences between treatment groups, provided that the normality test is satisfied and the homogeneity of variance test is not satisfied. Based on the analysis of the viscosity values using the Gomes-Howell post hoc test, no significant differences were observed among the groups, as indicated in the following results:

- F0 and F1: There is no significant difference between F0 and F1 because the Sig. The value is 0.072, which is greater than 0.05. With a mean difference of 172.667 and a 95% confidence interval between -27.6674 and 373.0008.
- F0 and F2: There is no significant difference between F0 and F2 with a Sig. value of 0.071, which is greater than 0.05. The mean difference is 80.0000, and the 95% confidence interval is between -13.8026 and 173.8026.
- F0 and F3: There is a significant difference between F0 and F3 with a Sig. value of 0.024, which is less than 0.05. The mean difference is 110.3333, with a 95% confidence interval ranging from 26.0048 to 194.6619.
- F1 and F0: There is no significant difference between F1 and F0 with a Sig. value of 0.072, which is greater than 0.05. The mean difference is -172.6667, and the 95% confidence interval is between -373.0008 and 27.6674.
- F1 and F2: There is no significant difference between F1 and F2 with a Sig. value of 0.278, which is greater than 0.05. The mean difference is -92.6667, with a 95% confidence interval ranging from -331.0847 to 145.7514.
- F1 and F3: There is no significant difference between F1 and F3 with a Sig. value of 0.480, which is greater than 0.05. The mean difference is -62.3333, and the 95% confidence interval is between -289.6979 and 165.0312.
- F2 and F0: There is no significant difference between F2 and F0 with a Sig. value of 0.071, which is greater than 0.05. The mean difference is -80.0000 with a 95% confidence interval between -173.8026 and 13.8026.
- F2 and F1: There is no significant difference between F2 and F1 with a Sig. value of 0.278, which is greater than 0.05. The mean difference is 92.6667, and the 95% confidence interval is between -145.7514 and 331.0847.
- F2 and F3: There is no significant difference between F2 and F3 with a Sig. value of 0.071, which is greater than 0.05. The mean difference is 30.3333, with a 95% confidence interval of -13.0668 to 73.7333.
- F3 and F0: There is a significant difference between F3 and F0 with a Sig. value of 0.024, which is less than 0.05. The mean difference is -110.3333, and the 95% confidence interval is between -194.6619 and -26.0048.
- F3 and F1: There is no significant difference between F3 and F1 with a Sig. value of 0.480, which is greater than 0.05. The mean difference is 62.3333, and the 95% confidence interval is between -165.0312 and 289.6979.
- F3 and F2: There is no significant difference between F3 and F2 with a Sig. value of 0.130, which is greater than 0.05. The mean difference is -30.3333, with a 95% confidence interval ranging from -73.7335 to 13.0668.

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Conclusion

This study aims to formulate and evaluate a liquid shampoo formulation combining patchouli leaf extract (Pogostemon cablin Benth.) and coconut oil as an anti-dandruff shampoo with varying concentrations of active ingredients. Based on the formulation process and a series of physical tests conducted, it was found that the resulting shampoo formulation possesses physical characteristics consistent with cosmetic standards, including organoleptic properties, homogeneity, pH, viscosity, and foam height. Skin irritation tests conducted on 15 respondents also indicated that all formulations are safe for use. Among all the tested formulations, formulation 2, which combined 0.75% nilam leaf extract with 3% coconut oil, was identified as the most optimal. The novelty value of this study lies in the integration of two potential natural ingredients into a single topical formulation scientifically designed to address dandruff issues.

These findings make a significant contribution to the field of herbal-based cosmetics, particularly in the development of shampoo products that are not only effective but also safe and environmentally friendly. Practically, the results of this study can serve as a reference for the cosmetics industry in designing hair care products based on natural ingredients. From a managerial perspective, this study provides an economical and standardized formulation solution that aligns with market preferences for herbal-based products.

This study has several limitations, including a limited scope of testing, which was confined to physical tests and simple irritation tests with a relatively small number of respondents. Additionally, no microbiological efficacy tests were conducted against dandruff-causing agents such as Malassezia sp. Therefore, it is recommended that future research expand the scope of testing to include long-term stability testing, clinical trials involving a larger number of subjects, and direct antimicrobial activity testing. Further research may also consider the addition of other supportive active ingredients to enhance the cosmetic and therapeutic functions of the developed shampoo formulation.

References

Anggraeni, Y., Nisa', F., & Betha, O. S. (2020). Karakteristik Fisik dan Aktivitas Antibakteri Sabun Cair Minyak Nilam (Pogostemon cablin Benth.) yang Berbasis Surfaktan Sodium Lauril Eter Sulfat. Jurnal Kefarmasian Indonesia, 10(1 SE-Articles), 1–10. https://doi.org/10.22435/jki.v10i1.499

Aswandi, A., Kholibrina, C. R., & Kuspradini, H. (2024). Essential Oils for Cosmetics Application BT - Biomass-based Cosmetics: Research Trends and Future Outlook (E. T. Arung, W. Fatriasari, I. W. Kusuma, H. Kuspradini, K. Shimizu, Y. Kim, N. I. W. Azelee, & Z. Edis (eds.); pp. 151–173). Springer Nature Singapore. https://doi.org/10.1007/978-981-97-1908-2_7

Bartkutė, E. (2024). Formulation and Evaluation of Herbal Shampoo. https://lsmu.lt/cris/entities/etd/d468e74a-21dd-487e-a3c6-d4fc3b0da4be

Barve, K., & Dighe, A. (2016). The Chemistry and Applications of Sustainable Natural Hair Products. Springer. https://doi.org/10.1007/978-3-319-29419-3

Borda, L. J., & Wikramanayake, T. C. (2015). Seborrheic Dermatitis and Dandruff: A Comprehensive Review. Journal of Clinical and Investigative Dermatology, 3(2). https://doi.org/10.13188/2373-1044.1000019

Cano-Reinoso, D. M., Purwanto, Y. A., Budiastra, I. W., Kuroki, S., Widodo, S., & Kamanga, B. M. (2021). Determination of α-guaiene and azulene chemical content in patchouli aromatic oil (Pogostemon cablin Benth.) from Indonesia by Near-infrared spectroscopy. Indian Journal of Natural Products and Resources (IJNPR)[Formerly Natural Product Radiance (NPR)], 12(2), 256–262.

OPEN ACCESS
e-ISSN: 2985-9808

Elshall, A. A., Ghoneim, A. M., Abdel-Mageed, H. M., Osman, R., & Shaker, D. S. (2022). Ex vivo permeation parameters and skin deposition of melatonin-loaded microemulsion for treatment of alopecia. Future Journal of Pharmaceutical Sciences, 8(1). https://doi.org/10.1186/s43094-022-00418-4

Fan, Y., Zhang, Q., Zhang, W., Lai, Y., Long, H., Huang, H., Zhan, S., Liu, X., Lai, J., & Zhang, Z. (2023). Inhibitory effects of Patchouli alcohol on the early lifecycle stages of influenza A virus. Frontiers in Microbiology, 13, 938868. https://doi.org/10.3389/fmicb.2022.938868

Fatimah, S., Nadifah, F., & Burhanudin, I. (2016). Uji daya hambat ekstrak etanol kubis (Brassica oleracea var. capitata f. alba) terhadap bakteri Staphylococcus aureus secara in vitro. Biogenesis: Jurnal Ilmiah Biologi, 4(2), 102–106. https://doi.org/10.24252/bio.v4i2.2515

Fauziyah, R. N., Widyasanti, A., & Filianty, F. (2020). Pembuatan Sampo Cair Berbahan Baku Minyak Kelapa (Coconut Oil) Dengan Penambahan Infused Oil Daun Mimba (Azadirachta Indica). Agroindustrial Technology Journal, 4(2), 87. https://doi.org/10.21111/atj.v4i2.4918

Feng, X.-X., Yu, X.-T., Li, W.-J., Kong, S.-Z., Liu, Y.-H., Zhang, X., Xian, Y.-F., Zhang, X.-J., Su, Z.-R., & Lin, Z.-X. (2014). Effects of topical application of patchouli alcohol on the UV-induced skin photoaging in mice. European Journal of Pharmaceutical Sciences, 63, 113–123. https://doi.org/https://doi.org/10.1016/j.ejps.2014.07.001

Gondokesumo, M. E., Sapei, L., Wahjudi, M., & Suseno, N. (2023). Virgin Coconut Oil. Deepublish Publisher.

Hafyyan, M., Widyasanti, A., & Rosalinda, S. (2024). Formulasi Pembuatan Sampo Cair Dengan Penambahan Minyak Nilam (Pogostemon cablin B.). Seminar Nasional Pariwisata Dan Kewirausahaan (SNPK), 3(SE-Articles), 679–684. https://doi.org/10.36441/snpk.vol3.2024.288

Hasriyani, H., Krisgiantara, N., Djamal, J. M., Murharyanti, R., & Etikasari, R. (2021). Ujisifat Fisik Gel Ekstrak Herba Pegagan (Centella asiatica (L.) Urban) Dengan Variasi Konsentrasi Carbopol Sebagai Gelling Agent. Prosiding University Research Colloquium, 0(0 SE-Articles), 329–335. https://www.repository.urecol.org/index.php/proceeding/article/view/1416

Jeong, J. B., Shin, Y. K., & Lee, S.-H. (2013). Anti-inflammatory activity of patchouli alcohol in RAW264.7 and HT-29 cells. Food and Chemical Toxicology, 55, 229–233. https://doi.org/https://doi.org/10.1016/j.fct.2012.12.062

Kim, S., & Ahn, C. (2023). Determination of penetration and protection of fatty acids in bleached hair according to the fatty acid chain length and the application to understanding the protective effects of MCT oil and coconut oil. Fashion and Textiles, 10(1), 10. https://doi.org/10.1186/s40691-023-00332-0

Krunali, T., Dhara, P., Meshram, D. B., & Mitesh, P. (2013). Evaluation of standards of some selected shampoo preparation. World J. Pharm. Pharm. Sci, 2(5), 3622–3630. https://www.researchgate.net/profile/Dhananjay-Meshram-2/publication/258567387_Evaluation_Of_Standards_Of_Some_Selected_Shampoo_Preparation/links/00463528afdbd918a3000000/Evaluation-Of-Standards-Of-Some-Selected-Shampoo-Preparation.pdf

Lestari, D. A., Juliantoni, Y., & Hasina, R. (2021). Optimasi formula sampo ekstrak daun pacar air (Impatiens balsamina L.) dengan kombinasi natrium lauril sulfat dan cocamide DEA. Sasambo Journal of Pharmacy, 2(1), 23–31. https://doi.org/10.29303/sjp.v2i1.72

Narayanankutty, A., Illam, S. P., & Raghavamenon, A. C. (2018). Health impacts of different edible oils prepared from coconut (Cocos nucifera): A comprehensive review. Trends in Food Science & Technology, 80, 1–7. https://doi.org/https://doi.org/10.1016/j.tifs.2018.07.025

Ng, Y. J., Tham, P. E., Khoo, K. S., Cheng, C. K., Chew, K. W., & Show, P. L. (2021). A comprehensive review on the techniques for coconut oil extraction and its application. Bioprocess and Biosystems Engineering, 44(9), 1807–1818. https://doi.org/10.1007/s00449-021-02577-9

Prayogo, D. D., Habibah, M. N., Azmi, M. R., Dewi Maharani, P. A., Permatasari, D. F., Akbar, U., Alexander, H., Nabilah, K., Sari, A. R., & Nugroho, N. A. (2024). Profil Pengetahuan, Ketepatan Tindakan, dan Pemilihan Produk dalam Mengatasi Ketombe pada Mahasiswi Berhijab di Universitas Airlangga. Jurnal Farmasi Komunitas, 11(1). https://doi.org/10.20473/jfk.v11i1.52621

OPEN ACCESS
e-ISSN: 2985-9808

Putri, A., Natalia, D., & Fitriangga, A. (2021). Hubungan Personal Hygiene Terhadap Kejadian Pityriasis Capitis Pada Siswi di SMK Negeri 1 Mempawah Hilir. Jurnal Nasional Ilmu Kesehatan, 4(1), 10–19.

Rosalina, Y. (2023). Formulasi Dan Uji Efektivitas Emolient Rambut Pada Shampo Kombinasi Virgin Coconut Oil (VCO) Dan Minyak Kemiri (Aleurites Moluccana Oil). http://localhost:8080/xmlui/handle/123456789/5361

Sakamoto, K., Lochhead, R. Y., Maibach, H. I., & Yamashita, Y. (2017). Cosmetic science and technology: theoretical principles and applications. Elsevier.

Setiaji, B., & Prayugo, S. (2006). Membuat VCO berkualitas tinggi. Jakarta: Penebar Swadaya.

Su, Z., Liao, J., Liu, Y., Liang, Y., Chen, H., Chen, X., Lai, X., Feng, X., Wu, D., & Zheng, Y. (2016). Protective effects of patchouli alcohol isolated from Pogostemon cablin on lipopolysaccharide-induced acute lung injury in mice. Experimental and Therapeutic Medicine, 11(2), 674–682. https://doi.org/10.3892/etm.2015.2918

Suryani, S., Sariani, S., Earnestly, F., Marganof, M., Rahmawati, R., Sevindrajuta, S., Mahlia, T. M. I., & Fudholi, A. (2020). A comparative study of virgin coconut oil, coconut oil and palm oil in terms of their active ingredients. Processes, 8(4), 402. https://doi.org/10.3390/pr8040402

Tagle, F. R. (2018). Automatic virgin coconut oil (VCO) extractor. MATEC Web of Conferences, 192, 1045. https://doi.org/10.1051/matecconf/201819201045

Varma, S. R., Sivaprakasam, T. O., Arumugam, I., Dilip, N., Raghuraman, M., Pavan, K. B., Rafiq, M., & Paramesh, R. (2019). In vitro anti-inflammatory and skin protective properties of Virgin coconut oil. Journal of Traditional and Complementary Medicine, 9(1), 5–14. https://doi.org/https://doi.org/10.1016/j.jtcme.2017.06.012

Wan, F., Peng, F., Xiong, L., Chen, J., Peng, C., & Dai, M. (2021). In Vitro and In Vivo Antibacterial Activity of Patchouli Alcohol from Pogostemon cablin. Chinese Journal of Integrative Medicine, 27(2), 125–130. https://doi.org/10.1007/s11655-016-2452-y

Xie, J., Lin, Z., Xian, Y., Kong, S., Lai, Z., Ip, S., Chen, H., Guo, H., Su, Z., Yang, X., Xu, Y., & Su, Z. (2016). (−)-Patchouli alcohol protects against Helicobacter pylori urease-induced apoptosis, oxidative stress and inflammatory response in human gastric epithelial cells. International Immunopharmacology, 35, 43–52. https://doi.org/https://doi.org/10.1016/j.intimp.2016.02.022

Žlabienė, U., Bartkutė, E., & Bernatonienė, J. (2024). Unlocking the Potential: A Comprehensive Analysis of the Technological Properties and Consumer Perception of Shampoo Enriched with Patchouli Extract and Allantoin. Cosmetics, 11(2), 53. https://doi.org/10.3390/cosmetics11020053

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