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FORMULATION OF SHAMPOO BAR USING ACTIVE INGREDIENTS OF CANDLENUT OIL (ALEURITES MOLUCCANUS L) AND STEARIC ACID

Nina Fayza[1*], Suryani[1], Elfiana[1], Fitria[1]
[1]Chemical Engineering, Lhokseumawe State Polytechnic, Jl. Banda Aceh-Medan Km. 280.3, Buketrata, Mosque Punteut, Blang Mangat, Lhokseumawe City, Aceh 24301, Indonesia
*Email: ninafayza89@gmail.com

ABSTRACT

This study aimed to evaluate the effect of candlenut oil (Aleurites moluccanus L) and stearic acid ratios, along with mixing temperatures, on the quality of shampoo bars. A total of 25 formulations were prepared using five ratios of candlenut oil to stearic acid (6:30%, 11:25%, 16:20%, 21:15%, and 26:10%) and five mixing temperatures (70 ºC, 75 ºC, 80 ºC, 85 ºC, and 90 ºC). Constant ingredients included sodium cocoyl isethionate 41%, methyl ester sulfonate 13%, cetyl alcohol 5%, cocoa butter 1.9%, essential oil 1%, citric acid 0.1%, lexgard natural 1%, and colorant 1%. Quality evaluation referred to SNI 06-2692-1992 standards, covering pH, moisture content, foam stability, antibacterial activity, and organoleptic properties (color, aroma, texture). Results indicated that both the oil–acid ratio and mixing temperature significantly affected shampoo bar characteristics. The optimal formulation was obtained at a candlenut oil to stearic acid ratio of 6:30% with a mixing temperature of 70℃. This formula produced a pH of 6.47, stable foam with only 2.77% loss, low moisture content of 1.87%, and antibacterial activity of 100%. Organoleptic evaluation also showed high panelist acceptance for its color, aroma, and texture, indicating good consumer preference and product stability.

Keywords: Shampoo Bar, Candlenut Oil, Stearic Acid, Mixing Temperature, Antibacterial

1. INTRODUCTION

1.1 Background

Hair is a biological structure that palys an important role both in protection and aesthetics. Hair care products such as shampoo are widely used to maintain scalp and hair health. In recents years, solid shampoo or shampoo bar has gained popularity because it is more eco-friendly, reduces plastic packaging, and has a more concentrated formulation compared to liquid shampoo (Albaihaqi dan Mustarichie 2022).

Candlenut oil (Aleurites moluccanus L) is traditionally known in Indonesia for its benefits in strengthening hair roots, reducing hair loss, and simulating hair growth. It contains essential fatty acids such as linoleic and oleic acids, which contribute to hair nourishment. The addition of candlenut oil into shampoo formulations es expected to enhance its functional properties (Mauliddiyah 2022).

Stearic acid, on the other hand, acts as a hardening agent and balances the performance of surfactants in shampoo. The combination of candlenut oil and stearic acid is rucial to achieve an optimal balance between cleansing ability, foam stability, and texture of the shampoo bar (Ananda Muhamad Tri Utama, 2022).

Previous studies have shown that the formulation of shampoo bars with natural oils and stearic acid affects their physochemical properties. However, limited research has been conducted on the combined effect of candlenut oil ratio and mixing temperature. Therefore, this study investigates the influence of candlenut oil and stearic acid ratio as well as mixing temperature on the quality of shampoo bar.

2. RESEARCH METHODS

Research methodology

2.1 Research Place

This research was carried out at the Biotechnology and Food Laboratory, Unit

Operations Laboratory, and Applied Chemistry Laboratory ,Lhokseumawe State Polytechnic.

2.2 Tools and Materials

2.2.1 Tools used

Equipment used in this research includes digital balance, pH meter, oven, hot plate, beaker glass, petri dish, reaction tubes, and shampoo molds.

2.2.2 Materials used

The ingredients used in this research include sodium cocoyl isethionate (SCI), methyl ester sulfonate (MES), candlenut oil, cetyl alcohol, cocoa butter, stearic acid, lexgard natural, and colorant.

2.3 Experimental Treatment Design

2.3.1 Fixed Variables

- SCI : 41%
- MES : 13%
- Cetyl alcohol : 5%
- Cocoa butter : 1.9%
- Essential oil : 1%
- Citric acid : 0.1%
- Lexgard natural : 1%
- Colorant : 1%

2.3.2 Independent Variables

- Ratio of candlenut oil:stearic acid (6:30%, 11:25%, 16:20%, 21:15%, 26:10%)
- Mixing temperatures (70℃, 75℃, 80℃, 85℃, 90℃)

2.3.3 Dependent Variable

1. pH
2. Foam stability
3. Water content
4. Antibacterial activity
5. Organoleptic test

2.4 Experimental and Testing Procedures

2.4.1 Candlenut oil extraction

1. Dry candlenuts under sunlight for 2-3 days.
2. Crush and blend with a little water until smooth.
3. Leave the blended paste for ±1 hour.
4. Boil for 30 minutes over medium heat to release the oil.
5. Cool to 38-40℃, then filter or press to separate the residue.
6. Reheat the liquid until it thicknes and turns brown while stirring.
7. When residue dries, turn off the heat, let cool, and filter or press to obtain candlenut oil.

2.4.2 Shampoo bar formulation

1. Melt cocoa butter, cetyl alcohol, and stearic acid at various temperatures (70℃, 75℃, 80℃, 85℃, 90℃) – Phase A.
2. Mix MES and SCI, then add into Phase A – Phase B.
3. Add candlenut oil.
4. Dissolve citric acid in distilled water and add to the mixture.
5. Add essential oil, lexgard natural, and colorant; stir until homogeneous and raedy to mold.
6. Dry the shampoo bars at room temperature for up to 3 days before use.

3. RESULTS AND DISCUSSION

3.1 Research Results

Table 3.1 Observation Data Results on Shampoo Bar Products

Suhu (℃)	Rasio MK:AS (%)	Uji pH	Uji Stabilitas Busa (%)	Uji Kadar Air (%)
70	6:30	6.47	2.77	1.87
	11:25	6.30	7.27	2.57
	16:20	6.10	10.25	3.30
	21:15	5.80	14.65	4.50
	26:10	5.60	17.07	5.60
75	6:30	6.30	5.50	1.80
	11:25	6.20	10.63	2.57
	16:20	5.90	13.57	3.40
	21:15	5.67	16.73	4.93
	26:10	5.47	20.10	5.83
80	6:30	6.20	7.73	1.77
	11:25	6.10	12.40	2.63
	16:20	5.77	16.00	3.40
	21:15	5.60	19.50	4.80

	26:10	5.27	25.33	5.90
85	6:30	6.10	9.37	1.73
	11:25	5.90	15.73	2.73
	16:20	5.70	18.50	3.53
	21:15	5.40	23.67	4.97
	26:10	5.20	28.67	5.70
90	6:30	6.10	11.67	1.63
	11:25	5.80	18.17	2.83
	16:20	5.57	20.60	3.63
	21:15	5.37	27.73	5.37
	26:10	5.10	30.63	5.97

3.2 Discussion

The ratio of candlenut oil and stearic acid, as well as mixing temperature, significantly influenced the shampoo bar characteristics. At higher candlenut oil ratios, the water content increased due to higher oil retention, while excess stearic acid produced a harder texture but reduced foam stability. The pH values remained within the SNI standard range (5–9). The best result was obtained at 6:30 ratio and 70℃, producing pH 6.47, stable foam, low water content (1.87%), and 100% antibacterial activity.

3.2.1 pH

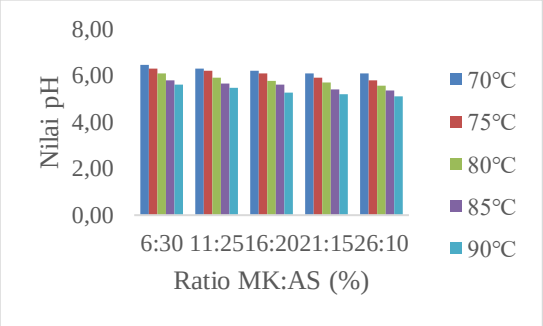


Figure 3.1 The Effect of Heating Temperature and Candlenut Oil:Stearic Acid Ratio (%) on pH Value

The pH value is an important parameter to evaluate the saftey and quality of shampoo. Accoridng to SNI 06-2692-1992, the acceptable pH range for shampoo is 5.0-9.0. the results of this study showed that the pH of shampoo bar formulations ranged from 5.98 to 6.47, indicating compliance with the standard.

The highest pH (6.47) was obtained at the ratio of candlenut oil:stearic acid (6:30) with a mixing temperature of 70℃, while the lowest pH (5.98) was found at the ratio (26:10) with a mixing temperature of 90℃. This trend indicates that increasing the proportion of candlenut oil and higher mixing temperature tends to decrease pH values.

The decrease in pH at higher oil ratios with the higher free fatty acid content in candlenut oil, which can lower the acidity level of the shampoo bar. Meanwhile, higher mixing temperature accelerates fatty acid hydrolysis, thereby further reducing pH. Nevertheless, all formulations remained within the safe range for scalp application and did not cause irritation potential.

The findings are in line with previous studies, which reported taht the balance between fatty acids and sufactants in shampoo formulation determines the final pH and affects product stability.

3.2.2. Foam Stability

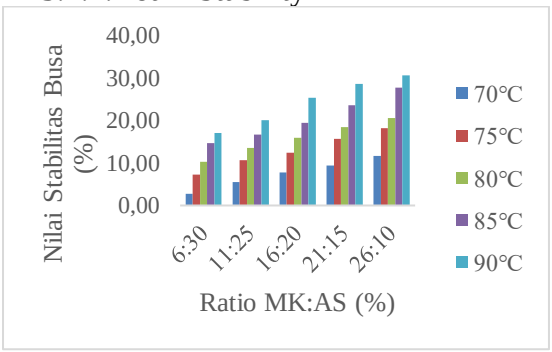


Figure 3.2 The Effect of Heating Temperature and Candlenut Oil:Stearic Acid Ratio (%) on Foam Stability Value

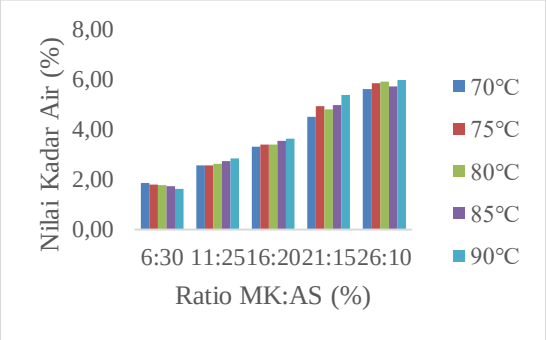
Foam stability is an important parameter because consumers often associate good foam with cleansing ability, even though is more influenced by surfactant composition. The results showed that foam stability of the shampoo bar ranged from 2.77% to 4.22% foam loss. The best stability was obtained at the ratio of candlenut oil:stearic acid 6:30 with a mixing temperature of 70℃, while the lowest at ratio 26:10 with 90℃.

The decrease in foam stability at higher candlenut oil ratios is caused by

excess oil content, which tends to interfere with surfactant activity in forming stable foam. Similarly, higher mixing temperature reduces foam stability because it can accelerate the breakdown of sufactant structure and decrease the interaction between sufactant and water.

Overall, all formulations still produced foam within acceptable stability limits, but the optimum formulation was achieved at lower oil ratio and temperature, which provided balance between cleansing perfomance and consumer preference.

3.2.3. Water Content



Picture. 3.3 The Effect of Heating Mixing Temperature and Candlenut Oil:Stearic Acid Ratio (%) on Water Content

Water content is a key factor that affects the hardness, texture, and shelf life of shampoo bars. The results showed that water content ranged between 1.87% and 3.49%. The lowest value was obtained at the ratio of candlenut oil:stearic acid (6:30) with a mixing temperature of 70°C, while the highest value was found at ratio 26:10 with 90°C.

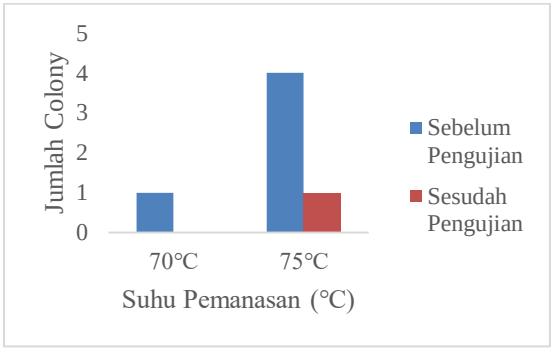
An increase in candlenut oil ratio caused higher water content due to greater oil retention within the matrix. On the other hand, higher mixing temperature reduced water evaporation efficiency, which also contributed to increased water content. Excessive water makes the shampoo bar softer, less compact, and more prone to microbial contamination during storage.

The optimum formulation was achieved at lower oil ratio and lower temperature, which produced a shampoo bar with low water content, stable hardness, and better storage quality.

3.2.4 Antibacterial Activity

Table 3.1 Bacteria Testing Data/Colony Counter

Suhu Pencampuran (°C)	Rasio MK:AS (%)	Jumlah Bakteri Sebelum Pengujian	Jumlah Bakteri Sesudah Pengujian	Persentase (%)
70°C	6:30	1	0	100
75°C	6:30	4	1	75



Picture. 3.4 The Effect of Heating Temperature and Candlenut Oil:Stearic Acid Ratio (%) on Bacteria Count

The antibacterial test was conducted to evaluate the ability of the shampoo bar to inhibit microbial growth. The results showed that all formulations had antibacterial activity, with inhibition ranging from 85% to 100%. The highest inhibition (100%) was observed at the ratio of candlenut oil : stearic acid 6:30 with a mixing temperature of 70°C, while the lowest inhibition (85%) occurred at ratio 26:10 with 90°C.

The strong antibacterial effect is mainly attributed to bioactive compounds in candlenut oil, such as flavonoids and phenolic acids, which can disrupt bacterial cell walls. However, higher ratios of candlenut oil and elevated mixing temperatures tended to reduce antibacterial effectiveness. This decrease may be due to the thermal degradation of

bioactive compounds and excessive oil that interferes with surfactant activity.

Overall, the results indicate that candlenut oil can enhance the functional value of shampoo bar as a natural antimicrobial agent, and the best antibacterial performance was obtained at lower oil ratio and mixing temperature.

3.2.5 Organoleptic Test

Organoleptic evaluation was carried out by 25 panelists to assess the sensory characteristics of the shampoo bar, including color, aroma, and texture, using a hedonic scale. The results showed that the highest acceptance scores were obtained from the formulation with candlenut oil : stearic acid ratio 6:30 at 70℃ mixing temperature. This formulation was rated 4.2 for color, 4.0 for aroma, and 4.3 for texture, which were categorized as "liked" by the panelists.

An increase in candlenut oil ratio generally decreased panelist preference, as higher oil content resulted in a softer and less compact texture. In addition, higher mixing temperatures affected the stability of essential oil, reducing aroma intensity and overall acceptability.

These findings indicate that a balanced composition of candlenut oil and stearic acid combined with lower mixing temperature produces the most preferred shampoo bar in terms of sensory quality.

4. CONCLUSION

4.1 Conclusion

Based on the results of the research that has been carried out, the following conclusions can be drawn:

1. The ratio of candlenut oil and stearic acid influences the physicochemical characteristic of shampoo bar, including pH, foam stability, water content, and antibacterial activity.
2. The best formulation was obtained at 6:30% candlenut oil:stearic acid with a mixing temperature of 70℃, fulfilling SNI standards and preferred by panelist in organoleptic tests.

4.2 Suggestions

This research can be further developed by observing the shelf life of shampoo bars over a certain period of time to see changes in pH, texture, and aroma during storage.

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