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FORMULATION AND PHYSICAL QUALITY TESTING OF SOLID SOAP COMBINATION OF CITRONELA OIL (*Cymbopogon nardus*) WITH EXTRACT BAJAKAH TAMPALA (*Spatholobus littoralis Hassk*) AGAINST BACTERIA *Staphylococcus aureus*

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ABSTRACT

Soap is an essential product in daily life for cleansing the body from dust and dirt that adhere to the skin. Citronella oil and Bajakah Tampala are plants that possess antibacterial activity and can be used as raw materials for the production of solid antibacterial soap. This study aimed to determine the physical quality characteristics of citronella oil solid soap with a combination of Bajakah Tampala extract and perform an antibacterial activity test. The method employed was experimental, involving the formulation of solid soap and several preliminary tests such as organoleptic testing, pH testing, homogeneity testing, and foam stability testing. Antibacterial activity tests were conducted using the disc diffusion method. The results of this study indicate that the addition of citronella oil and Bajakah Tampala extract to solid soap influenced the antibacterial activity against *Staphylococcus aureus*, exhibiting a very strong inhibitory effect in Formula 3 at 100%. In the physical quality testing of the solid soap formulation, the results were in accordance with the Indonesian National Standard (SNI). The conclusion of this research is that the physical quality characterization of the soap is in line with established standards, and the solid soap formulation has proven antibacterial activity.
Keywords: Citronella, Bajakah tampala, Staphylococcus aureus, Solid soap

INTRODUCTION

Soap is an essential product in people's daily lives and is used to clean the body from dust and dirt that adheres to the skin (Hamzah et al., 2021a). Diseases, such as skin diseases caused by bacteria and fungi, can be treated with soap. In other words, soap can be used as a remedy by cleansing the body, thereby reducing the likelihood of disease (Rifqi et al., 2021). The use of antibacterial soap is considered a solution because it is believed to cleanse the skin and prevent skin infections (Oktiana et al., 2021).

The skin is located on the outer part of the body. Its function is to protect tissues and organs; hence, the need to protect the skin, one of which is the use of soap (Rusli et al., 2019). Staphylococcus aureus is a common bacterium that infects skin. *Staphylococcus aureus* is a gram-positive coccus, the most prevalent skin pathogen, and the most common bacterium found on the human skin. It is a normal member of the skin and mucosal flora in humans, and is a common cause of infections (Jayuska

and Alimuddin, 2020).

The prevention of skin infections can be addressed using soap containing antibacterial compounds (Rizka Mastura, 2021). Therefore, an active ingredient is needed to provide benefits to soap, and cleansing agents can act as antioxidants and prevent infections and microbes.

Citronella (*Cymbopogon nardus* L) is a plant with numerous benefits, including treatment of coughs, headaches, stomachaches, and diarrhea, acting as an antipyretic, repelling mosquitoes, and providing warmth. It is also used as a fragrance in soaps, sprays, polishes, and disinfectants (Nadirah and Destiara, 2022). Citronella plants have been proven to have antibacterial activity against *Staphylococcus aureus*, and they are also known to contain flavonoids, polyphenols, saponins, and essential oils (Susilowati and Syukur, 2022). Bajakah contains phytochemicals, such as saponins, phenolics, flavonoids, and tannins, and acts as an antibacterial agent by inhibiting nucleic acid synthesis and cell membrane function, and disrupting energy metabolism (Azahara and Khadafi, 2023).

From the description above, this serves as a reference for formulating solid soap preparations aimed at determining the physical quality characteristics of citronella oil solid soap combined with bajakah tampala extract and assessing its antibacterial activity.

RESEARCH METHODS

Equipment and Materials

The equipment used in this research included beaker glass, measuring glass, funnel, dropper pipette, hand-blender, water bath, porcelain cup, volumetric flask, digital scale, perforator, pH meter, autoclave, paper discs, silicone soap mold, Erlenmeyer flask, filter paper, test tube, evaporating dish, ose/loop, hot plate, cotton swab, petri dish, ruler, and micropipette.

The materials used were *citronella oil* and Bajakah tampala extract, NaOH, distilled water, coconut oil, Nutrient Agar, 96% ethanol, *and Staphylococcus aureus* bacteria.

Research Procedure

Collection and Preparation of Test Materials

The testing equipment was prepared in the Microbiology Laboratory and Natural Material Chemistry Laboratory at Muhammadiyah University of East Kalimantan. Citronella essential oil was obtained from an e-commerce platform, while bajakah tampala extract was obtained from the laboratory's collection.

Solid Soap Formulation

Prepare equipment and materials to make solid soaps. All ingredients were weighed according to the formulation. NaOH solution by mixing 22.08 grams of NaOH with 51.52 ml of distilled water and stir until dissolved. Next, 120 grams of coconut oil was mixed, followed by adding citronella oil and bajakah extract were added, and the mixture was stirred until a homogeneous mixture was formed. Next, pour the mixture into the mold and let it sit. The soap was prepared at room temperature for 1-3 days to solidify completely (Purwati and Safitri, 2021).

Table I. Formulation of Solid Soap Preparation From Combination of Citronella Oil and Bajakah Tampala Extract

Material Name	F1	F2	F3	Utility	Reference
Coconut Oil	120 g	120 g	120 g	Fatty Acid	(Rowe et al., 2009)
NaOH	22,08 g	22,08 g	22,08 g	Alkali	
Distilled Water	51,52 ml	51,52 ml	51,52 ml	Solvent	
Citronella Oil	0 %	2 %	1 %	Active	

				Ingredients
Bajakah Tampala exctract	0%	1 %	2 %	Active Ingredients

Physical Quality Test

According to research conducted by Purwati and Safitri (2021), physical quality testing performed on solid soap preparations may include the following aspects:

1. Organoleptic Test

   This test was conducted by observing smell, color, and texture (Purwati and Safitri, 2021).
2. pH Test

   In this test, the solid soap was weighed at 0.1 gram. The soap was then soaked in 10 ml of distilled water, and the pH of the soap was checked using a pH meter. Observations were made on the pH of distilled water before and after soaking in solid soap. If the pH of the soap reaches 9-11, then the soap meets the pH standard (Purwati and Safitri, 2021).
3. Homogeneity Test

   This test was conducted by dissolving the sample in a glass or other transparent container. The preparation must have a homogeneous composition and should not contain visible small or coarse particles (Purwati and Safitri, 2021).
4. Foam Stability Test

   This test was conducted by weighing 1 gram of the soap sample, placing it in a measuring glass containing 10 ml of distilled water, and shaking it for 30 seconds. The height of the foam formed was measured using a ruler (initial foam height). The foam height was measured again after 5 minutes (final foam height), and the stability was calculated using the following formula:

   $$\text{Missing foam} = \frac{final\ foam\ height}{initial\ foam\ height} \text{ x } 100\%.$$

   $$\text{Foam Stability} = 100\% - \text{missing foam}$$

   Good foam stability was achieved when the foam retains approximately 60-70 - 100% of its initial height after 5 minutes (Fitri et al., 2023).

Making Bacterial Subcultures

5 grams of NA powder is weighed out. It was then dissolved in 250 ml of distilled water and mixed in an Erlenmeyer flask. Afterward, it was heated to boiling temperature and dissolved in a water bath. The medium was sterilized at 121 °C in an autoclave for 15 minutes. The medium was then poured into petri dishes and allowed to solidify (Fijriati and Maulana, 2022).

***Staphylococcus aureus* bacterial suspension**

Staphylococcus aureus bacteria were collected using an ose/loop that had been heated with a Bunsen flame and placed into a test tube filled with 10 ml of sterile NaCl and then shaken until homogeneous (Putri et al., 2019).

Antibacterial Activity Test

Antibacterial activity tests were conducted using the disc diffusion method. The diluted bacteria were evenly spread on the agar surface using a cotton swab (Hamzah et al. 2021b). Discs containing the preparation and discs containing positive and negative controls were placed on agar containing the bacterial suspension. The cells were then incubated for 24 hours at 37ºC. After incubation, bacterial growth was observed and the diameter of the inhibition zone was measured (Bhernama, 2020).

Inhibition Zone Test on *Staphylococcus aureus* Bacteria

The inhibition zone was measured by measuring the outer edge of the disc with calipers or a ruler until it reached the outer boundary of the inhibition zone (Safitri and Fatmawati, 2021).

RESULTS AND DISCUSSION

In this study, solid soap preparations were prepared using citronella oil as the active ingredient and Bajakah tampala. Three solid soap formulations were prepared at different concentrations. F1 was prepared with a soap base consisting of NaOH and coconut oil, F2 was made with a soap base containing 1% citronella oil and 0.5% bajakah extract, and F3 was made with a soap base containing 0.5% citronella oil and 1% bajakah extract. The results for solid soap are shown in **Figure 1**.

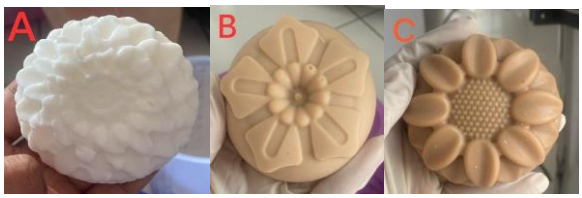

Figure 1. Results of Citronella Oil Solid Soap and Bajakah Tampala Extract, (A) F1 Basis, (B) Formula 2, and (C) Formula 3

Phsycal Quality Test

Organoleptic Test

Table II. Organoleptict Test For 4 Weeks

Testing	Formula	4 weeks time				Conclusion
		M1	M2	M3	M4	
Color	F1	Milky white	Milky white	Milky white	Milky white	Stable
	F2	Light brown	Light brown	Light brown	Light brown	
	F3	Dark brown	Dark brown	Dark brown	Dark brown	
Smell	F1	Typical soap aroma	Typical soap aroma	Typical soap aroma	Typical soap aroma	Stable
	F2	Aroma of citronella oil.	Aroma of citronella oil.	Aroma of citronella oil.	Aroma of citronella oil.	
	F3	Aroma of citronella oil.	Aroma of citronella oil.	Aroma of citronella oil.	Aroma of citronella oil.	
Texture	F1	Solid	Solid	Solid	Solid	Stable
	F2	Solid	Solid	Solid	Solid	
	F3	Solid	Solid	Solid	Solid	

In **Table II**, the results of a 4-week storage evaluation of solid soap formulations combining Bajakah tampala extract and citronella oil, F1, F2, and F3, concluded that there were no changes in color, aroma, or texture from the testing.

Based on the results of the study conducted by Zulbayu et al. (2020), the test results showed no changes from the first week to the fourth week, which is consistent with the findings of the researcher.

Homogenity Test

Table III. Homogeneity Test Results Data

Formulation	Homogeneity				Conclusion
	M1	M2	M3	M4	
Formula 1 (base)	Homogeneous	Homogeneous	Homogeneous	Homogeneous	Stable
Formulasi 2	Homogeneous	Homogeneous	Homogeneous	Homogeneous	Stable
Formula 3	Homogeneous	Homogeneous	Homogeneous	Homogeneous	Stable

Based on **Table III**, the homogeneity test data for F1, F2, and F3 from the first week to the fourth week concluded that the tests resulted in homogenous outcomes, attributed to the absence of particles in the soap. According to the research conducted by Suryadini et al., (2023), it was found that the solid soap remained homogeneous, with evenly mixed color and no other particles.

pH Test

Table IV. Data from pH Test Results

Formulation	Reseacrh time				Average
	M1	M2	M3	M4	
Formula 1 (base)	9,0	9,0	9,2	9,5	9,17
Formula 2	8,6	9,0	9,2	9,3	9,05
Formula 3	8,8	8,9	9,3	9,3	9,07

Evaluation of the data obtained over 4 weeks showed that for F1, the average pH from week 1 to 4 was 9.17, for F2, the average pH from week 1 to 4 was 9.05, and for F3, the average pH from week 1 to 4 was 9.07. According to Putri et al. (2021), the pH test meets the standard. This indicated that the results were relatively safe for the skin.

Foam Stability Test

Table V. Data on Foam Stability Test Results

Formulation	High foam preparation				Average
	M1	M2	M3	M4	
Formula 1 (base)	67,75%	76,93%	62,30%	58,63%	66,40%
Formula 2	61,30%	93.85%	56,61%	74,14%	71,48%
Formula 3	62,23%	80%	48,34%	64,92%	63,87%

Based on **Table V**, the evaluation of the foam stability test of solid soap formulations containing Bajakah tampala extract combined with citronella oil in formulations 1, 2, and 3 from weeks 1 to 4 indicated that the soap formulations were stable. This is because F1, F2, and F3 had foam stability percentages of 66.40%, 71.48%, and 63.87%, respectively. According to research conducted by Fitri et al. (2023), the foam stability results are in line with the standard range of 60-70%.

Antibacterial Activity Test

Table VI. Inhibitory Power Test Results Data

Formulation	Inhibition zone diameter			SD±	Information
	R1	R2	R3		
K-	0mm	0mm	0mm	0mm	-
K+	48mm	48mm	48mm	48mm	Very strong
F2 50%	7mm	25,5mm	27,5mm	20	Strong
F2 100%	20,5mm	29mm	36,5mm	28,6mm	Very strong
F3 50%	6,5mm	31mm	37,5mm	25mm	Very strong
F3 100%	14mm	31,5mm	42,5mm	29,3mm	Very strong

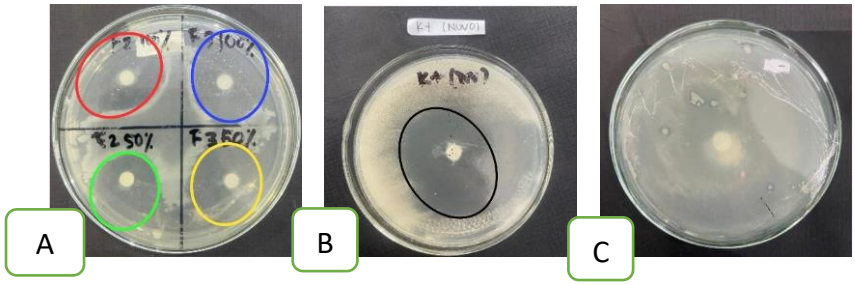

Figure 2. Results of Observation of Inhibitory Power, (A) F1 (does not use the active ingredients of citronella oil and Bajakah Tampala extract), (B) F2 (citronella oil concentration 2% and bajakah tampala extract 1%), (C) F3 (citronella oil concentration 1% and bajakah tampala extract 2%)

Figure 2 shows the presence of inhibition zones formed by soap preparations, indicated by the formation of clear zones around the paper discs (Wijianto et al., 2022). The diameters of the inhibition zones were classified into four groups based on their activity: ≤ 5 mm diameter, categorized as weak, 6-10 mm categorized as moderate, 11-20 mm categorized as strong, and ≥21 mm, very strong (Safitri and Fatmawati, 2021).

In **Table VI**, the results of the resistance test from the average value of F2 50% are in the strong resistance category, and F2 100%, F2 50%, and F3 100% have very strong resistance, as well as the 48 mm positive control in the very category. strong and for negative control, namely distilled water, there was no formation of an inhibition zone (Hamzah et al., 2021b).

The formation of the inhibitory zone was caused by the soap formulation containing the active ingredients Bajakah Tampala extract and lemongrass oil diffusing and inhibiting the growth of Staphylococcus aureus in the medium on the paper discs. The higher the concentration of the formulation, the larger the diameter of the inhibition zone (Latu, 2023). Because the formulation was divided into four concentrations in the petri dishes used, it may have a stronger inhibitory effect than the positive control.

According to the results of this research, it is stated that this research is in accordance with that carried out by Rinaldi et al., (2021) who stated that *Staphylococcus aureus* bacteria with citronella plant soap preparations have a very strong inhibitory power because they have an inhibitory diameter that falls within the activity range, namely ≥ 20 mm. According to the results of research conducted by Latu (2023), *Staphylococcus aureus* bacteria with the Bajakah Tampala plant has a very strong inhibitory power because it has an activity range of ≥ 21 mm.

CONCLUSION

Based on the research results, citronella and Bajakah tampala plants can be used as solid soap preparations, and the physical quality characterization of the preparations has been conducted according to established standards, and the formulation of solid soap preparations has been proven to inhibit the growth of *Staphylococcus aureus* bacteria.

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