

Formulation and Physical Quality Testing of Solid Soap From a Combination of Citronella Oil with Patchouli Leaf Oil Againsts *Staphylococcus aureus* Bacteria

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ABSTRACT

Bacteria on the skin can cause infections ranging from mild to quite serious. Bacteria that are commonly found on human skin are the pathogenic bacteria *Staphylococcus aureus*. The choice for making antibacterial solid soap based on active ingredients from patchouli oil and citronella oil is that this oil has inhibitory power in the growth of bacteria on the skin, one of which is *S. aureus*. The aim of this research is to determine how large the inhibition zone is produced by the antibacterial solid soap formulation and to determine the characteristics and physical quality tests of the solid soap preparation combining citronella oil with patchouli leaf oil so that it is safe to use. The method used is a pure experimental method. Data collection was carried out for 4 weeks according to the testing time and then analyzed using the Graphad application. The results of the research on the inhibition zone test used 2 concentrations, namely 50% and 100%, each formulation had different average results, namely at F2 with 50% the average was 21 mm with a very strong category, at F2 with 100% the average was 19.5 mm with the strong category, at F3 with 50% we get an average of 16 mm in the strong category and at F3 with 100% we get an average of 18.6 mm in the strong category. In the tests that have been carried out, it was concluded that citronella oil and patchouli leaf oil can be made into antiseptic solid soap and can inhibit the growth of *S. aureus* bacteria. The results of testing physical quality characteristics for 4 weeks have met the standard requirements for solid soap.

Keywords: Antiseptic solid soap, citronella oil, patchouli oil, *Staphylococcus aureus*

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Introduction

Skin is the most important part of the human body and is tasked with protecting the inside of the body from heat, cold and bacteria. Skin is an organ located outside the body. The function of the skin is to protect the body's tissues and organs, therefore it is necessary to protect the skin, one of which is by using soap [1].

Staphylococcus aureus is a round Gram-positive bacterium with a diameter of 0.7-1.2 μm , in irregular clusters like grapes, does not form spores, is facultative anaerobic, and does not move [2]. *Staphylococcus aureus* is also the main pathogenic bacteria for humans. Almost everyone has experienced skin infections due to *S. aureus* bacteria during their life, from skin infections that are not too severe to quite severe [3].

Indonesia has many plants that have antibacterial potential, one of which is patchouli and citronella. The patchouli plant is one of the main essential oil producing plants in Indonesia and has high economic value. Indonesia is the largest supplier of patchouli oil in the global market, where almost 70% of the world's total patchouli oil comes from Indonesia [4]. The citronella plant is a grass plant that is widely cultivated by people in Southeast Asia. Citronella plants are included in intercropping crops, where plants are planted involving more than one type of plant on one agricultural

land. Based on research by Nurhamidin *et al.* [5], it has been proven that essential oils from citronella and patchouli leaf oil have antibacterial activity on human skin, so it is necessary to combine these two natural ingredients.

Essential oils are compounds that are generally in liquid form and are obtained through steam distillation of several parts of plants such as roots, bark, stems, leaves, fruit, seeds or flowers [6]. The essential oil of the patchouli plant is known to contain the compound patchouli alcohol which is effective against bacteria on the skin, namely *S. aureus*. The essential oil contained in citronella is one of the essential oils that has the greatest antibacterial activity, this is because citronella oil contains an active compound, namely citronellal. Citronella oil also contains active compounds such as saponins, alkaloids, flavonoids and polyphenols. Flavonoid and saponin compounds are also known to have antibacterial activity. Considering the antibacterial properties found in the essential oils of citronella and patchouli plants, it is interesting to process them into formulations such as antiseptic solid soap preparations [7].

Materials and Methods

Materials

The tools used in this research digital scales, pH meters, erlenmeyer, autoclaves, hot plate, incubator. All equipment used uses the Iwaki® brand.

The ingredients used have different uses, coconut oil was used as a surfactant or fatty acid, NaOH was used as a compactor or solid ingredient, aquadest was used as a solvent, while citronella oil and patchouli leaf oil were used as active ingredients or active substances.

The ingredients that used in making this soap were patchouli leaf oil and citronella oil which was produced in Indonesia, NaOH, distilled water, coconut oil, nutrient agar, 0.9% NaCl, cotton, gauze, cotton balls, cotton swabs, aluminum foil, and *S. aureus* bacteria.

Table 1. Formulation of solid soap preparations from a combination of citronella oil and patchouli leaf oil

Ingredient	F1 (0%)	F2 (2%)	F3 (3%)
Coconut oil (g)	120	120	120
NaOH (g)	22.08	22.08	22.08
Aquadest (mL)	52.5	52.5	52.5
Citronella oil (%)	0	2	1
Patchouli oil (%)	0	1	2

Methods

The tools and materials were prepared to make solid soap, then all the ingredients were weighed according to the formula. After that, NaOH solution was made by mixing 22.08 g NaOH with 52.5 mL of distilled water and stir until dissolved. Then 120 g of coconut oil was mixed, added citronella oil and patchouli leaf oil according to the concentration requirements in each formulation and mix thoroughly using a hand blender until a trace is formed, which is a thickened mixture. After that, the soap mixture was poured into the silicone mold and the soap preparation was left at room temperature for 1-3 days so that the soap hardens completely [8].

The evaluation carried out was the physical quality characteristics of the solid soap preparation which would be seen and observed the changes over 4 weeks. Physical quality characteristic tests include organoleptic tests, pH tests, foam stability tests, and homogeneity tests.

Foam stability was calculated based on the formula written in the equation (1). The pH of soap was calculated based on the formula written in the equation (2). The zone of inhibition was calculated based on the formula written in the equation (3).

$$\% \text{ Missing foam} = \frac{\text{Final foam height}}{\text{Initial foam height}} \times 100\% \quad (1)$$

$$\frac{\text{pH Week 1} + \text{pH week 2} + \text{pH week 3} + \text{pH week 4}}{4} \quad (2)$$

$$\text{The zone of inhibition} = \frac{(Dv - Dc) + (DH - Dc)}{2} \quad (3)$$

Information :

Dv : Vertical diameter

DH: Horizontal Diameter

Dc: Disc Diameter

Result

This research used 5 tests, namely physical quality characteristic tests which included: organoleptic test, pH test, homogeneity test, and foam stability test. Meanwhile, for testing bacteria, use the paper disc diffusion method with nutrient agar media. Physical quality characteristics testing was carried out for 4 weeks, and testing on bacteria was carried out 3 times. Data analysis used in the bacterial inhibition zone test was using graphade.

The results of the organoleptic analysis can be seen in **Figure 1**. The results of the pH test can be seen in **Table 2**. The results of the homogeneity test can be seen in **Table 3**. The results of the foam stability test can be seen in **Table 4**. The results of the *S.aureus* inhibition test can be seen in **Table 5**.

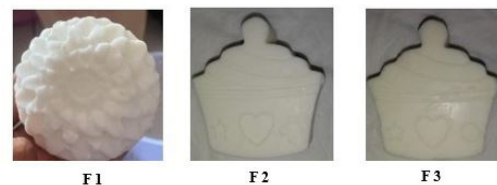


Figure 1. Solid soap formulation with a combination of patchouli oil and citronella oil. F1 (does not use the active ingredients patchouli oil and citronella oil). F2 (concentration of citronella oil 2% and patchouli oil 1%) F3 (Concentration of patchouli oil 2% and citronella oil 1%)

Table 2. pH test results

Formulation	pH Results				Average
	Week 1	Week 2	Week 3	Week 4	
F 1	9.0	9.0	9.2	9.5	9.18
F 2	8.9	8.9	9.3	9.3	9.1
F 3	8.9	9.1	9.1	9.3	9.1

Table 3. Homogeneity test results

Formulation	Homogeneity Test Results			
	Week 1	Week 2	Week 3	Week 4
F 1	Homogeneous	Homogeneous	Homogeneous	Homogeneous
F 2	Homogeneous	Homogeneous	Homogeneous	Homogeneous
F 3	Homogeneous	Homogeneous	Homogeneous	Homogeneous

Table 4. Foam stability test results

Formulation	Week 1 (%)	Week 2 (%)	Week 3 (%)	Week 4 (%)	Average (%)
Formulation 1	71.43	76.93	62.3	58.63	67.55
Formulation 2	71.43	80.4	57.15	77.59	71.64
Formulation 3	72.92	86.8	51.43	41.38	63.13

Table 5. Test for the inhibition of *S. aureus* results

Formulation	Diameter Of The Inhibition Zone			Average (mm)	Information
	R1 (mm)	R2 (mm)	R3 (mm)		
K-	0	0	0	0	-
K+	48	48	48	48	Very Strong
F2 50%	15.5	20	28	21	Very Strong
F2 100%	17.5	26	15	19.5	Strong
F3 50%	12	11.5	24.5	16	Strong
F3 100%	22.5	17.5	16	18.6	Strong

R = Radius

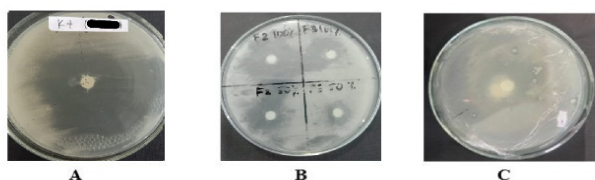


Figure 2. *Staphylococcus aureus* bacteria inhibition zone. A = positive control (N soap) (100% concentration), B = F2 100%, F2 50%, F3 100%, F3 50%, C = negative control (aquadest) (100% concentration)

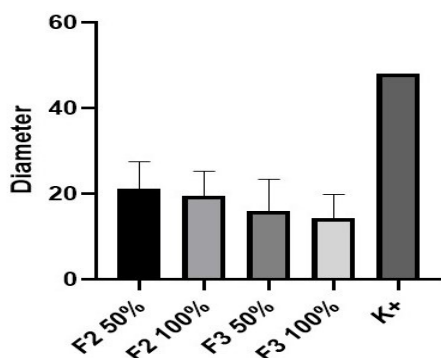


Figure 3. *Staphylococcus aureus* bacterial inhibition zone test graph (diameter in mm)

Discussion

Analysis Organoleptic

Organoleptic analysis was carried out with the aim of determining the color, odor, texture and shape of the solid soap. This testing was carried out for 4 weeks. The results of this test show that each formulation has a different color because there are differences in the concentration of active ingredients. The organoleptic results for the 3 formulas did not change from week 1 to week 4, only there were differences in the color and aroma of each formula. Based on 2 previous studies conducted by Putri *et al.*, [9], organoleptic results showed that there were no significant changes in texture, color and aroma. Based on the results of research by Dewi and Lestari [10] from the first week to the fourth week, this is in accordance with what researchers have done where there was no change.

pH Exam

Soap pH testing was carried out for 4 weeks, and formula 1 had an average result of 9.18, formula 2 had an average pH of 9.1, and the average pH in formula 3 had an average pH of 9.1. The pH value obtained shows that the soap preparation is alkaline. This is in accordance with the required pH value for solid soap preparations, namely 9-11. Based on research conducted by Zulbayu *et al.* [11]. The pH results of solid bath soap ranged from 9.99 - 10.42 and the pH of solid antiseptic bath soap ranged from 9.99 - 10.47. These results meet the requirements for a safe pH value for soap, namely 9 – 11 [12].

Homogeneity Test

The homogeneity test was carried out with the aim of seeing whether there was butyram in the soap preparation. The homogeneity test of the solid soap preparation was carried out by first dissolving the preparation using distilled water on a piece of glass. After that, observe that the ingredients are not mixed evenly or there are grains. Based on the results of the

homogeneity test, the homogeneous soap preparation from week 1 to week 4 was homogeneous or the ingredients used were evenly mixed for all formulas. So that the ingredients used in making soap have been mixed perfectly. Based on these results, solid soap has fulfilled the organoleptic evaluation test because the formula is organoleptically stable.

Foam Stability Test

The aim of foam stability is to determine the stability of foam produced by solid soap preparations using different concentrations of patchouli oil and citronella oil. The criteria for good foam stability, if within 5 minutes the foam stability range is between 60-70%. The soap foam stability results obtained from all formulas met the soap stability requirements. In research conducted by Ariska *et al.* [8], there was a foam stability test which showed that foam stability was in accordance with the parameters, namely at F1 it was 68% according to the foam stability criteria. Within 5 minutes it was said to be stable if the foam stability was in the range of 60 - 70%.

Staphylococcus aureus Bacterial Inhibition Test

Testing the antibacterial activity of *S. aureus* used the disc paper diffusion method on agar media, namely nutrient agar. This research used two concentrations, namely 50% and 100% of the solid soap formula of citronella with patchouli leaf oil. For the positive control, use aquadest and for the negative control, use N brand solid soap. The results obtained are that formula 2 solid soap with citronella oil combined with patchouli oil can inhibit the growth of *S. aureus* bacteria to a greater extent than the other formulas [13]. These results were influenced by the large concentration of added citronella oil, namely 2%. Based on research conducted by it was found that the results of adding 3 grams of citronella to formula 3, in inhibiting the growth of *S. aureus* bacteria, had the largest diameter of the inhibition zone, namely 22.1 mm. According to citronella contains saponins and flavonoids which can inhibit the growth of *S.aureus* bacteria [14]. Based on data analysis, the P value of N brand soap with F2 50% is 0.0008, N brand soap with 100% F2 is 0.0004, N brand soap with 50% F3 is 0.0002 and N brand soap with 100% F3 namely < 0.0001 [15].

Conclusion

Citronella oil and patchouli leaf oil made into a solid soap formulation has been proven to inhibit the growth of *S. aureus* bacteria. Not only testing for bacteria, several tests were carried out including organoleptic tests, pH tests, homogeneity tests, and soap foam stability tests which were carried out for 4 weeks. The results of all tests carried out for 4 weeks have met the standard values for a solid soap preparation.

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