FORMULATION OF LIQUID HAND SOAP MADE FROM CITRONELLA ESSENTIAL OIL *(Cymbopogon nardus L.)*

Windi Permatasari[1], Helmi Haris[2]

[1] Student of Agroindustrial Technology, Faculty of Halal Food Science, Djuanda University, Indonesia
[2] Lecture of Halal Food Science Faculty, Djuanda University, Indonesia
Corresponding Author: permatawindi1@gmail.com

Abstract

Hand washing with water and soap is one of the prevention efforts through sanitization measures by cleaning hands and fingers using water and soap. This study aims to formulate liquid hand washing soap with citronella essential oil as a natural antibacterial component. This research method is a laboratory experimental research design, namely by making a preparation of citronella essential oil hand wash liquid soap *(Cymbopogon nardus L.)* with a concentration variation of 5%, 10% and 15%. Natural liquid soap was made through saponification reaction between oil and potassium hydroxide. Soap characterization includes parameters: pH, organoleptic, homogeneity, viscosity, foam stability and antibacterial activity testing. The results showed that the yellow color with liquid form and the characteristic odor of fragrant citronella essential oil were stable. The pH value of the formulated liquid hand washing soap does not differ much ranging from pH 7 to 8. The results of the homogeneity test conducted, no changes occurred before and after testing. The viscosity of liquid soap shows that all liquid soap preparation formulas have increased viscosity values and are in the required range. The results of foam height have values that tend to change from the four formulas. However, this measurement is in accordance with the required value, which means that the foam remains stable. The antibacterial activity test shows that citronella essential oil liquid soap preparations can inhibit the growth of *Escherichia coli* and *Staphylococcus aureus* bacteria. Therefore, it is proven that citronella essential oil is effective as an antibacterial component in liquid hand soap formulations.

Keywords: antibacterial, citronella oil, liquid soap

I. INTRODUCTION

Human hands are often the agents that carry bacteria and cause pathogens to pass from one person to another through direct or indirect contact. Hand washing with water and soap is one of the preventive measures through sanitization by cleaning hands and fingers using water and soap. It is more effective at mechanically removing dirt and dust from the skin surface and significantly reduces the number of disease-causing microorganisms such as viruses, bacteria and other parasites on both hands (1).

Liquid soap is a liquid soap preparation intended for cleaning the skin, made from soap base material to which surfactants, preservatives, foam stabilizers, fragrances and dyes are added, and can be used for bathing without irritating the skin (2). Liquid soap is made through a saponification process using oil and alkali potassium hydroxide (KOH). This type of soap has the advantage that its liquid form allows the reaction of soap on the surface of the skin faster than solid soap. Another advantage of liquid soap is that it is more hygienic in storage and more practical to carry when traveling (3).

The provision of liquid soap by maximizing the use of natural ingredients as active substances is still not widely developed. One of the natural ingredients that has been proven to inhibit the growth of bacteria is citronella oil (4). The chemical content of citronella essential oil which is antibacterial is citronella, citronellol and geraniol (5). Citronella oil (Cymbopogon Nardus) taken from citronella leaves through the steam distillation method has a natural active substance, Citronella, which is effective against the inhibition of *Staphylococcus Aureus* bacteria (6).

The most important chemicals in citronella oil are aldehyde compounds, namely citronellal and alcohol compounds, namely citronellol and geraniol. Citronella essential oil is obtained from the distillation of citronella plants containing 32-45% citronellal, 11-15% citronellol, 10-12% geraniol, 3-8% geranil acetate, 2-4% (7) .Citronellal acetate these compounds in citronella oil not only provide aromatic (pleasant smell), but also are compounds with therapeutic properties, and provide protection from oxidation and decay processes by microorganism (8).

Based on the description above, the purpose of this research is to formulate natural hand washing liquid soap with the addition of citronella essential oil *(Cymbopogon Nardus)* with various concentrations. Physico-chemical properties and antibacterial activity were evaluated to determine the quality of the liquid soap.

II. METHODOLOGY

The tools used are autoclave, stirring rod, bunsen, petridish cup, porcelain cup, funnel, elenmeyer, beaker, measuring cup, pH paper, ose, oven, pipette, test tube rack, spatula, stamper, test tube, analytical balance, timer, and viscometer.

The materials used are distilled water, aluminum foil, stearic acid, Escherichia coli bacteria, Staphylococcus aureus bacteria, potassium hydroxide (KOH), Nutrient agar (NA) media, methyl paraben, citronella essential oil *(Cymbopogon nardus L.)*, olive oil, sodium carboxyl methyl cellulose (Na-CMC), sodium lauryl sulfate (SLS), sodium sulfate anhydride (Na_2SO4), and propyl paraben.

This research method is a laboratory experimental research design, namely by making hand washing liquid soap preparations of citronella essential oil *(Cymbopogon nardus L.)* with concentration variations of 5%, 10% and 15% which are then tested on the quality of soap.

Soap Preparation

All ingredients to be used are weighed first according to the dosage in the formula table. Put olive oil into a beaker, then add potassium hydroxide little by little while continuing to heat at 50ºC to get soap paste**.** Then the soap paste is added with approximately 5 ml of distilled water, then sodium carboxy methyl cellulose which has been developed in hot distilled water is stirred until homogeneous. Then added stearic acid stirred until homogeneous, after that added methyl paraben and propyl paraben stirred until homogeneous and added sodium lauryl sulfate stirred homogeneous After that, fragrant lemongrass essential oil is stirred until homogeneous, then distilled water is added to the liquid soap until the volume is 50 ml. Then put in a clean container. The preparation of fragrant citronella essential oil liquid soap is adjusted to each concentration (1). The liquid soap making formulation can be seen in Table 1.

Soap characteristics

Soap characterization includes parameters: pH, organoleptic, homogeneity, viscosity, foam stability and antibacterial activity testing.

a. pH

   Performed by taking a liquid soap preparation of citronella essential oil as much as 1 gram of sample dissolved in 10 ml of distilled water. Then the pH paper is dipped into the sample solution and then allowed to change color to show the pH until the position is constant and the number shown is the value of the pH of the preparation

b. Organoleptic

   Organoleptic test was conducted to observe the shape, color and smell of the preparation liquid soap (9). The standard set by SNI is that the liquid form has a distinctive odor and color.

c. Homogeneity

   Performed by dripping fragrant lemongrass essential oil liquid soap preparation on a glass object then leveled. Observed homogeneity by looking at the parts that are not well mixed in the preparation. If there are no grains, the preparation can be said to be homogeneous.

d. Viskosity

This is done by placing the sample in a container, and adjusting the height of the container so that the rotor can move. The rotor is selected according to the level of viscosity of the liquid soap. Turn on the viscometer and observe the viscometer value indicated on the viscometer. Record the viscometer value.

e. Foam stability test

Foam stability test done by taking one mL liquid hand soap and inserting it into test tube which had been given scale, and then 5 mL of distilled water was added. The reaction tube was shaken strongly to form a foam and then the height of the foam formed was measured. The height of the formed foam was measured at 10 minutes (10).

f. Antibacterial activity

The antibacterial activity of citronella leaf essential oil was determined using the well diffusion method with a repetition of 3 times. The test solution of citronella essential oil liquid soap with different concentrations (5%, 10%, and 15%) was dripped on different wells as much as 50 µl using a micropipette. The liquid soap base solution used as a negative control was dripped on the wells as much as 50 µl using a micropipette. Dettol solution was used as a positive control dripped into the wells as much as 50 µl using a micropipette. Petri dishes were incubated in an incubator at 37ºC for 24 hours. The clear zone formed was then measured using a caliper.

Cycling Test

Cycling test is one of accelerated stability testing on preparations with different storage temperatures

in a certain time interval which aims to accelerate the occurrence of changes that usually occur under normal conditions (11). This test is accelerated by keeping the samples at 4ºC for 24 hours and then transferring them to an oven at 40ºC for 24 hours. This treatment is 1 cycle. The treatment was repeated for 6 cycles and observations were made with organoleptic parameters, homogeneity, pH, viscosity, and foam height.

Data analysis

Analysis of the data obtained using One Way Anova comparative statistics. to see the effect of variations in the concentration of citronella essential oil *(Cymbopogon nardus L.).* on hand washing liquid soap preparations.

III. RESULTS AND DISCUSSION

The soap making process is done through a saponification reaction. Saponification is an exothermic chemical reaction that occurs when fats or oils (fatty acids) come into contact with alkali, a base. In this reaction, the triglyceride units of fats react with potassium hydroxide and are converted to soap and glycerol. There are many variables that will impact saponification and different soap ingredients have very distinct characteristics (10). The natural liquid soap in this study uses olive oil as the basic ingredient. Other ingredients used include potassium hydroxide, sodium lauryl sulfate, sodium carboxyl methyl cellulose, stearic acid, methyl paraben, propyl paraben, distilled water and citronella oil used in different concentrations. The addition of citronella essential oil aims to give a distinctive aroma to the soap. The characteristics of liquid soap are divided into several criteria, namely pH, organoleptic, homogeneity, viscosity, foam stability and antibacterial activity.

a. pH

The pH value is a value that indicates the degree of acidity of a material. The degree of acidity (pH) is an important parameter in cosmetic products, because pH can affect the absorption capacity of the skin (12). The results of measuring the pH of liquid soap in each formula are not much different ranging from pH 7 to 8. In general, liquid soap products have a pH that tends to be alkaline. This is

caused by the basic ingredients that make up the liquid soap, namely KOH which is a strong base. Based on the Paired sample t-test pH test has a value of 0.874 (P>0.05), which shows there is no significant difference between the data before and after the cycling test. Based on the requirements of the pH value for the four formulas, it still meets the parameters of a good pH value, which is between 4-10. The pH value can be influenced by the amount of free alkali in the liquid soap. The higher the amount of free alkali, the higher the pH of the liquid soap will be. If more alkali is added, fatty acids are unable to bind all the alkali so that more free alkali causes a high soap pH (13). The results of the pH test of citronella essential oil liquid soap preparation (Cymbopogon nardus L.) before and after the cycling test can be seen in Table 2.

b. Organoleptic

Organoleptic test is a test that based on the sensory process (9). Organoleptic analysis was carried out by observing changes in shape, color, and odor of the liquid soap preparation during storage time (14). The hand washing liquid soap produced in this study produces a yellow color with a liquid form and a distinctive smell of fragrant citronella essential oil that is stable before and after testing.

c. Homogeneity

Homogeneity testing is one of the parameters that can state that the ingredients used in the preparation can mix with each other and form a stable liquid soap preparation.Homogeneity test aims to see the physical appearance of a preparation (15).The results of the tests carried out, there was no change before and after the cycling test. The results of the homogeneity test of citronella essential oil (Cymbopogon nardus L.) liquid soap preparations before and after the cycling test can be seen in Table 3.

d. Viskosity

Viscosity is two parameters that are of concern in liquid soap preparations. Viscosity aims to determine the consistency of the preparation, which will affect the application of the preparation such as easy to pour from the container but not easy to spill flowing from the hands (16). The results of the liquid soap viscosity test show that all liquid soap preparation formulas have increased viscosity values and are in the required range. This is because the high viscosity of the preparation will reduce the frequency of collisions between particles so that the preparation becomes stable (17). After the cycling test, it can be seen that the viscosity value of the liquid soap preparation has changed, each formula has decreased. Decrease in viscosity due to increase inwater or soap ratio because viscosity is affected by the water content in the soap (18). The results of the viscosity test of citronella essential oil liquid soap preparation (Cymbopogon nardus L.) before and after the cycling test in Table 4.

e. Foam stability test

Foam is one of the most important parameters in determining the quality of cosmetic products, especially soap. The purpose of foam testing is to see the foamability of liquid soap (3). In the measurements taken, it was found that the foam height test had a value that tended to change from the four formulas. However, this measurement is in accordance with the required value, which means that the foam remains stable. Based on the Paired sample t-test, the foam height test has a value of 0.028 (P>0.05), which shows that there is no significant difference between the data before and after testing. The results of the foam height test of citronella essential oil liquid soap preparation (Cymbopogon nardus L.) before and after the cycling test can be seen in Table 5.

f. Antibacterial activity

The antibacterial activity of citronella leaf essential oil against Escherichia coli and Staphylococcus aureus bacteria was determined using the well diffusion method. The results of the antibacterial activity test showed that citronella essential oil liquid soap preparation was able to inhibit the growth of Escherichia coli and Staphylococcus aureus bacteria. Citronella leaf essential oil shows antibacterial properties characterized by the formation of a clear zone. The main component of citronella essential oil is able to inhibit the growth of Escherichia coli and Staphylococcus aureus with

a diameter of 18.36 mm and 13.07 mm respectively, with its mechanism of action which is to damage the structure of the cell wall, so that it can result in disruption of metabolism or death of bacterial cells (19). Meanwhile, according to other studies, the chemical components of citronella essential oil, namely citronellal (16.9%), citronellol (10.4%), elemol (9.1%), and nerol (8%) are able to inhibit the activity of Escherichia coli and Staphylococcus aureus bacteria with a diameter of 18 mm and 14 mm respectively (20). The results of the antibacterial activity test of citronella essential oil liquid soap preparation (Cymbopogon nardus L.) can be seen in Table 6 and Figure Diameter of Inhibition Zone of Citronella Essential Oil Liquid Soap Preparation Activity (A: inhibition zone against S. aureus; B: inhibition zone against E. coli can be seen in Figure 1.

IV. CONCLUSIONS AND NEWNESS

This study shows that the formulation of essential oil liquid soap preparations in all formulations meets the requirements in accordance with the standards set by SNI, namely homogeneity test, pH test, viscosity test, foam height test, and antibacterial activity test. In activity testing on Escherichia coli and Staphylococcus aureus bacteria with 5% and 10% essential oil concentrations can inhibit bacteria with moderate categories. As for the concentration of essential oil 15% can inhibit bacteria with a strong category and is the highest zone with the diameter of the inhibition zone of Escherichia coli 11.04 mm and Staphylococcus aureus 11.81 mm.

V. REFERENCES

1. Yulen F, Rumlus P, Musdar TA, Meinar A, Rantisari D. Formulasi Dan Uji Aktivitas Antibakteri Sediaan Sabun Cair Cuci Tangan Minyak Atsiri Sereh Wangi *(Cymbopogon Nardus L .)* Terhadap Bakteri *Escherichia Coli* Dan *Staphylococcus Aureus.* 2022;148–61.
2. Badan Standardisasi Nasional. Tentang Sabun cair pembersih tangan. Jakarta. 2017
3. Rinaldi, Elfariyanti, Mastura R. Formulasi Sabun Cair Dari Ekstrak Etanol Serai Wangi *(Cymbopogon nardus L.).* J Sains Kesehat Darussalam. 2021;1(1):29–36.
4. Niah R, Ariani N, Febrianti DR. Formulasi Dan Evaluasi Sediaan Hand Wash Minyak Serai Wangi *(Cymbopogon nardus L. Rendle).* J Insa Farm Indones. 2022;5(2):258–66.
5. Cahyani IP. Formulasi Sediaan Sabun Mandi Cair Dengan Metode Panas Berbasis Minyak Atsiri Sereh Wangi (Cymbopogon nardus) Dan Uji Aktivitas Antibakteri Terhadap Staphylococcos aureus. 2018.
6. Febriyanti N, Asmara suci nura, Sundari E. Pembuatan Sabun Cair Antibakteri Dari Minyak Serai Wangi (Cymbopogon Nardus). Abstr Undergrad 2021;(19):19–20.
7. Sulaswatty A, Rusli, Sahaba, M A, Tursiloadi S. Quo Vadis Minyak Serai Wangi dan Produk Turunannya. 2014
8. Murni, Rustin L. Karakteristik kandungan Minyak Atsiri Tanaman Serai Wangi *(Cymbopogon nardus L .).* 2020. 227–31
9. Hutauruk HP, Yamlean PVY, Wiyono W. Formulasi Dan Uji Aktivitas Antibakteri Krim Ekstrak Etanol Herba Seledri *(Apium graveolens L.)* Terhadap Bakteri Staphylococcus aureus. Pharmacon J Ilm Farm. 2020;9(2):226.
10. Uzwatania F, Surya Ningrum R, Resti O S. Formulation of Liquid Hand Soap Made From Neem Seed Oil and Lemongrass Essential Oil. Indones J Appl Res. 2020;1(3):155–62.
11. Annisa Illahi Wahdati Alb. Pengaruh Variasi Konsentrasi Basis Kombinasi Vaselin Album dan Cera Alba Terhadap Sifat Fisik dan Stabilitas Fisik Salep Ekstrak Etanol Daun Binahong *(Anredera cordifolia (Ten.) Steenis)*. 2016;01:1–23.
12. Sari R, Ferdinan A. Pengujian Aktivitas Antibakteri Sabun Cair dari Ekstrak Kulit Daun Lidah

Buaya Antibacterial Activity Assay of the Liquid Soap from the Extract of Aloe vera Leaf Peel Abstrak. Pharm Sci. 2017;4(3):111–20.

13. Wulandari D, Ayu DF, Ali A. Pengaruh Minyak Atsiri Bangle *(Zingiber purpureum Roxb.)* sebagai Antibakteri terhadap Kualitas Sabun Cair. Agroindustri Halal. 2018;4(April):2442–3548.
14. Zahro K, Aulia SS, Azahra RS, Zaevany TA, Margaretha C, Naila J. Formulasi Dan Evaluasi Sediaan Sabun Cair Berbasis Virgin Coconut Oil (VCO) Dengan Penambahan Oleum Citri Sebagai Essential Oil. Indones J Heal Sci. 2023;3(2a):199–203.
15. Yusriyani, Syarifuddin K.A S. Formulasi dan Uji Mutu Fisik Sediaan Sabun Cair Ekstrak Kulit Buah Pisang Kepok *(Musa balbisiana)*. J Kesehat Yamasi Makasar. 2022;6(2):89–98.
16. Anggraeni Y, Nisa' F, Betha OS. Karakteristik Fisik dan Aktivitas Antibakteri Sabun Cair Minyak Nilam *(Pogostemon cablin Benth.)* yang Berbasis Surfaktan Sodium Lauril Eter Sulfat. J Kefarmasian Indones. 2020;0:1–10.
17. Faikoh E. Formulasi Sabun Cair Tanah Sebagai Penyuci Najis Mughalladzah dengan Variasi Tanah Koalin dan Bentonit. Fak Kedokt dan Ilmu Kesehat UIN Syarif Hidayatullah Jakarta. 2017
18. Sukeksi L, Sidabutar AJ, Sitorus C. Pembuatan Sabun Dengan Menggunakan Kulit Buah Kapuk *(Ceiba petandra)* Sebagai Sumber Alkali. J Tek Kim. 2017;6(3):8–13.
19. Shintawati S, Rina O, Ermaya D. Sifat Antimikroba dan Pengaruh Perlakuan Bahan Baku terhadap Rendemen Minyak Sereh Wangi (Antimicrobial Properties and Effects of Raw Material Treatments on Citronella Oil Yield). J Sylva Lestari. 2020;8(3):411.
20. Kamari F El, Taroq A, Atki Y El, Aouam I, Oumkhtar B, Lyoussi B, et al. *Cymbopogon Nardus L.* Essential Oil Phytochemical Screening and its Antibacterial Activity against Clinical Bacteria Responsible for Nosocomial Infections in Neonatal Intensive Care. 2018;50(03):14–7.

TABLES AND FIGURES

Table 1 Citronella Essential Oil Liquid Soap Formula

Material	Usability	Concentration (%)				
		F1	F2	F3	KN	KP
Citronella essensial oil	Active substance	5	10	15	-	Dettol
Olive oil	Moisturizer	5	5	5	5	-
Potassium hydroxide	Alkali	1,2	1,2	1,2	1,2	-
Sodium lauryl sulfate	Surfactants	2,5	2,5	2,5	2,5	-
Sodium carboxyl methyl selulosa	Thickener	2	2	2	2	-
Stearic acid	Foam stabilizer	0,25	0,25	0,25	0,25	-
Methyl paraben	Preservatives	0,18	0,18	0,18	0,18	-
Propil paraben	Preservatives	0,02	0,02	0,02	0,02	
Air suling ad	Solvent	50 ml	50 ml	50 ml	50 ml	-

Source : Yulen et al (2022)

Table 2 pH test results of citronella essential oil liquid soap preparation (Cymbopogon nardus L.) before and after cycling test

Ph					
No	**Preaparations**	**Before *CyclingTest***	**After *CyclingTest***	**condition**	**Significant**
1	KN	8	8		
2	F1	8	8	4 - 10	P>0,05
3	F2	7	7		
4	F3	7	7		

Souce : Yulen et al (2022)
Description: KN: Liquid soap base, F1: Liquid soap preparation concentration 5%, F2 : 10% concentration liquid soap preparation, and F3: Liquid soap preparation concentration of 15%.
Source : Yulen et al (2022)

Table 3 Homogeneity test results of citronella essential oil liquid soap preparation (Cymbopogon nardus L.) before and after cycling test

Homogeneity			
No	**Preparations**	**Before *Cycling Test***	**After *CyclingTest***
1	KN	Homogen	Homogen
2	F1	Homogen	Homogen
3	F2	Homogen	Homogen
4	F3	Homogen	Homogen

Source : Yulen et al (2022)

Table 4 Viscosity test results of citronella essential oil liquid soap preparation (Cymbopogon nardus L.) before and after cycling test

Viskosity					
No	**Preparations**	**Before *Cycling Test***	**After Cycling Test**	**Condition**	**Significant**
1	KN	3940	3670	500-20.000 cPs	P>0,05
2	F1	3520	3500		
3	F2	3820	3170		
4	F3	3930	890		

Source : Yulen et al (2022)

Table 5 Foam stability test results of citronella essential oil liquid soap preparation (Cymbopogon nardus L.) before and after cycling test

Foam Stability Test							
No	**Preparations**	**Before Cycling Test**		**After Cycling Test**		**Conditions**	**Significant**
		Minute 0	**Minute 5**	**Minute 0**	**Minute 5**		
1	KN	5,5	5	3	3	0,5-22 cm	P>0,05
2	F1	5,5	5	4,8	3,5		
3	F2	2,5	2	2,5	2,5		
4	F3	2,1	2	2	1,5		

Source : Yulen et al (2022)

Table 6 Antibacterial activity test results of citronella essential oil liquid soap preparation (Cymbopogon nardus L.)

No.	**Preparations**	**Inhibition zone diameter (mm)**		**Description**	**Significant**
		E.coli	***S.aureus***		
1	KP	13,41	14,11	Strong	
2	KN	0	0	None	
3	F1	6,58	9,53	Medium	P < 0,05
4	F2	9,03	8,7	Medium	
5	F3	11,01	11,81	Strong	

Source : Yulen et al (2022)

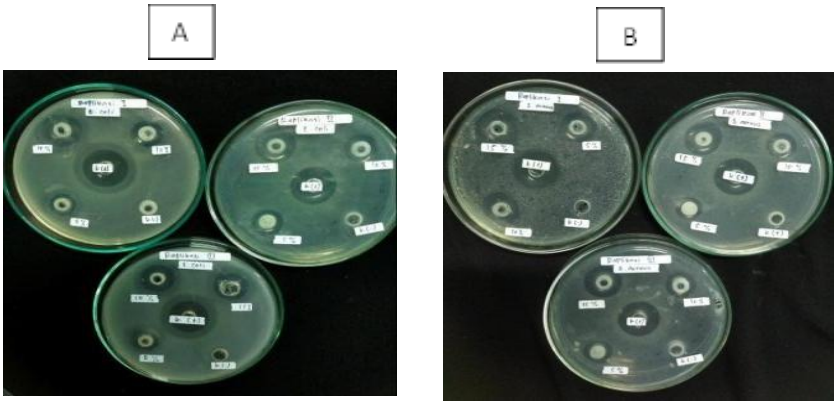

Figure 1 Diameter of zone of inhibition of citronella essential oil liquid soap (A: zone of inhibition against S. aureus; B: zone of inhibition against E. coli.
Source : Yulen et al (2022)