

The Effect Of Sodium Lauryl Sulphate (SLS) On The Formulation Of Lime (*Citrus aurantifolia*) Essential Oil Hand Soap

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Abstract

Liquid soap is currently the most popular soap product, due to its attractive and practical form. Soap is often enriched with several additives, such as surfactants, to improve its quality. The most common surfactant is Sodium Lauryl Sulphate (SLS), as it can reduce skin irritation and has excellent foaming properties. Adding too much SLS can cause irritation and dry skin. Hand soap can be formulated with natural active ingredients, such as lime peel essential oil, which contains antibacterial properties. This study was conducted by creating soap preparations in FI (0.75%), FII (1%), and FIII (1.25%). The purpose of this study was to determine the effect of varying SLS concentrations on the physical quality of hand soap preparations, including organoleptic tests, homogeneity tests, pH tests, viscosity tests, and foam height tests. The results of the study showed that the hand soap was thick, had a distinctive fresh lime odour, and was yellow in colour. The hand soap preparations for each formula were homogeneous. The pH of the three preparations ranged from 6.01 to 6.15. The viscosity of the three preparations ranged from 805 to 846.33 cPs. The foam height of the three formulas ranged from 48 to 55 mm. The conclusion of this study is that variations in SLS concentration affect the results of organoleptic tests, pH, viscosity, and foam height which show significant differences ($\text{sig} < 0.05$) between FI, FII, and FIII, but in the homogeneity test results, variations in SLS concentration do not affect the results of the homogeneity test which shows no significant difference ($\text{sig} > 0.05$) between FI, FII, and FIII.

Keywords: sodium lauryl sulphate, formulation, soap, *Citrus aurantifolia*

1. INTRODUCTION

Human health is crucial. Reducing the risk of infection is one way to stay healthy. According to research conducted by the Centre for Disease Control (CDC), maintaining hand hygiene is the best way to reduce the rate of infection and the transmission of antimicrobial-resistant organisms, as hands are the fastest way for microbes to enter the body. There are many simple ways to clean your hands, including using hand soap. Many diseases are caused by not washing your hands, such as typhus, fungal infections, polio, dysentery, diarrhoea, cholera, worms, acute respiratory infections, and hepatitis A. The most popular soap product today is liquid soap because it is more hygienic to store, has a more attractive shape, and is more practical to carry around (Rusli, 2022). Soap is typically enriched with active ingredients such as lime essential oil. Soap is also commonly enriched with additives such as surfactants to

improve its quality. Sodium Lauryl Sulphate (SLS) is a commonly added surfactant because it can reduce skin irritation and has excellent foaming properties. SLS is a very strong surfactant and is commonly used in products that remove oil and dirt stains. Its function is to increase the foaming effect of soap (a foaming agent) (Chasani *et al.*, 2022).

According to Marlina, (2022) SLS in soap formulation is suspected to affect the physical stability of the preparation, so it is necessary to vary the concentration to obtain a soap preparation formula that has good stability. Hand soap can be made using natural active ingredients, namely limes, which are often used as medicine and food preservatives. However, lime peels are underutilised due to a lack of awareness of their benefits, leading them to be wasted. Limes are rich in vitamin C, vitamin B1 (thiamine), calcium, phosphorus, carbohydrates, iron, fat, energy, protein, water, and essential oils (citral, limonene, feladen, lemon camphor, cadinene, and nitride) (Hasma *et al.*, 2023). Limes are also a source of essential oils. Lime essential oil contains 36.32% limonene, the active ingredient (Ulandari *et al.*, 2022). According to Apriyani (2013), lime essential oil at a concentration of 4% has antibacterial activity.

Development of essential oil-based hand washing soap preparations with a variety of surfactants is necessary. Based on research conducted by Chasani *et al.* (2022) as an effort to improve the quality of soap in terms of foaming, further study is needed regarding foaming in soap. Researchers are interested in conducting a study entitled "Formulation and Physical Quality Testing of Lime Essential Oil Hand Soap *Citrus aurantifolia* with Various Concentrations of SLS as a Surfactant. This research was conducted by formulating a hand soap preparation containing lime peel essential oil of *Citrus aurantifolia* with varying low SLS concentrations. This was expected to reduce irritation and dry skin and improve the stability of the foam produced. The resulting foam was then subjected to physical quality tests, including organoleptic tests, pH tests, homogeneity tests, viscosity tests, and foam height tests.

2. METHODS

Research Materials

The tools used in this research are: analytical balance (*Labex*®), pH meter, Brookfield viscometer, object glass. The materials used this research are: lime essential oil of *Citrus aurantifolia* (*Lansida Group*), glycerin (*technical*), CAPB (*Cocamidopropyl Betaine technical*), SLS (*technical*), Hydroxyethyl Cellulose (HEC) (*technical*), Sodium Chloride

(NaCl) (*technical*), methylparaben (*technical*), propylparaben (*technical*), buffer solution (*technical*), dye and distilled water.

Purchasing Lime Essential Oil of *Citrus aurantifolia*

Purchase lime essential oil (*Citrus aurantifolia*) at Lansida Laboratorium, located in Purbayan, Kotagede, Yogyakarta. To ensure the product is truly lime essential oil (*Citrus aurantifolia*), a certificate of analysis (COA) is included with the purchase.

Making Hand Soap

Prepare the necessary equipment and weigh the required ingredients. Add SLS to the first beaker, dissolve it in distilled water, and set it aside. Then, add NaCl to the second beaker and dissolve it in distilled water. Then, add the NaCl solution to the SLS (Sodium Lauryl Sulphate) solution. Add the propyl and methylparaben and stir until homogeneous. Once homogeneous, add the glycerin and stir until homogeneous. Next, add the HEC and stir until homogeneous. Then, add the CAPB. Finally, add the lime essential oil and stir until homogeneous. Add the remaining distilled water, stir until homogeneous, and add the desired colouring. The hand soap is ready to be packaged in bottles. Follow the same steps to make soap preparations with SLS concentrations of 1% and 1.25%. Hand washing soap preparations in each concentration variation were made and physical quality tests were carried out in 3 replications (Rumlus *et al.*, 2022).

Physical Quality Test

a. Organoleptic Test

Take a sample of 1 gram/1 mL of hand soap and observe the colour, odour, and appearance of the soap preparation (Robbia *et al.*, 2021).

b. Homogeneity Test

Take 1 gram/1 mL of hand soap and apply it to a glass slide to determine whether the preparation is homogeneous (Tungadi *et al.*, 2023).

c. pH Test

Dip a calibrated pH meter into the soap, wait until the reading remains constant, and then record the result (Rumlus *et al.*, 2022).

d. Foam Height Test

In this study, the foam height test was conducted by taking 1 gram/1 mL of soap, placing it in a test tube, adding 10 mL of distilled water, shaking the test tube by inverting it for 20 seconds, and measuring the foam height (Rumlus *et al.*, 2022).

e. Viscosity Test

Take 250 mL of soap and then perform a viscosity test using a Brookfield viscometer with spindle number 4 and a speed of 30 rpm. Wait a few moments and record the numerical scale on the instrument (Robbia *et al.*, 2021).

Data Analysis

The physical quality test data were tested for normality using the Shapiro-Wilk test and for homogeneity using the Test of Homogeneity of Variance. Data were considered normal and homogeneous if the sig value was > 0.05 , and ANOVA was used to determine the influence and/or differences between the two variables (Setyawan *et al.*, 2021). ANOVA results were obtained when the sig value was < 0.05 , thus rejecting H_0 .

3. RESULTS AND DISCUSSION

This study began with the manufacture of handwashing soap with the addition of varying levels of SLS (Sodium Lauryl Sulphate) as a foam former, namely FI (0.75%), FII (1%), and FIII (1.25%), to determine the effect of varying SLS (Sodium Lauryl Sulphate) additions on the physical quality test of handwashing soap. The hand soap formula can be seen in Table 1.

Table 1. Hand Soap Formula

Ingredients	Concentration (%)			Uses
	F1	FII	FIII	
Citrus aurantifolia essential oil	4	4	4	Active ingredient
Glycerin	8	8	8	Moisturiser
Hydroxyethyl Cellulose (HEC)	1	1	1	Thickener
Sodium lauryl sulphate	0.75	1	1.25	Foaming agent
Cocamidopropyl Betaine (CAPB)	11	11	11	Foam booster
Sodium Chloride (NaCl)	3	3	3	pH stabiliser
Methylparaben	0.18	0.18	0.18	Preservative
Propylparaben	0.02	0.02	0.02	Preservative
Colouring	0.05	0.05	0.05	Colouring
Aquadest ad	50mL	50mL	50mL	solvent

The results of the physical quality test of lime essential oil hand soap are shown in Table 2.

Table 2. Physical Quality Test of Lime Essential Oil Hand Soap

Parameter	Soap	Test Parameters				SNI Testing Standard
		Replication 1	Replication 2	Replication 3	$\bar{x} \pm SD$	
Organoleptic	Formula I	Shape = Thick*	Shape = Thick*	Shape = Thick*	-	
		Color = yellow	Color = yellow	Color = yellow		
	Formula II	Shape = Thick**	Shape = Thick**	Shape = Thick**	-	
		Color = yellow	Color = yellow	Color = yellow		
	Formula III	Shape = Thick***	Shape = Thick***	Shape = Thick***	-	
		Color = yellow	Color = yellow	Color = yellow		
Homogeneity	Formula I	Homogeneous	Homogeneous	Homogeneous	-	Homogeneous
	Formula II	Homogeneous	Homogeneous	Homogeneous	-	
	Formula III	Homogeneous	Homogeneous	Homogeneous	-	
pH	Formula I	6.00	6.02	6.03	6.01 ± 0.015^a	6 - 8
	Formula II	6.05	6.06	6.07	6.06 ± 0.010^b	
	Formula III	6.09	6.10	6.11	6.10 ± 0.010^c	
Foam Height	Formula I	44 mm	47 mm	50 mm	47 ± 3.000^a	13 – 220 mm
	Formula II	52 mm	54 mm	56 mm	54 ± 2.000^b	
	Formula III	58 mm	60 mm	62 mm	60 ± 2.000^c	
Viscosity	Formula I	801 cPs	805 cPs	809 cPs	805 ± 4.000^a	400 – 4.000 cPs
	Formula II	818 cPs	821 cps	846 cPs	821.67 ± 4.041^b	
	Formula III	843 cPs	846 cPs	850 cPs	846.33 ± 3.512^c	

Note:

*: Viscosity level

Different superscripts a, b, c: Different superscripts indicate significant differences ($p < 0.05$) based on one-way ANOVA, followed by post-hoc testing.

The table above shows that all three formulas are yellow. The yellow colour comes from the addition of dyes to enhance the appearance of the soap. The soap has a distinctive aroma from the fresh lime essential oil, and the soap's appearance is thick with varying degrees of viscosity in each formula. This is due to the varying concentration of SLS (Sodium Lauryl Sulphate), which functions as a surfactant that increases viscosity. These results are supported by Jayani *et al.* (2018), who explained that lime (*Citrus aurantifolia*) essential oil hand soap is yellow in colour with a distinctive, fresh lime odour and a thick texture (Jayani *et al.*, 2018). The homogeneity test aims to determine whether the active ingredients in the soap are evenly mixed. The table above shows that all three formulas are homogeneous. The results of the hand soap homogeneity test are shown in Table 2.

The pH test aims to determine the acidity/alkalinity of the soap. A pH that does not meet the standard can cause dry skin and irritation. The standard pH testing for liquid soap according

to SNI is a pH range of 6-8. The pH test results for the three formulas are shown in Table 2. Based on the table above, it shows that the pH of the preparation in each test replication experienced an increase in pH value. The increase in pH in each replication was influenced by the saponification process during soap making (Setiawati *et al.*, 2021). In addition, the speed and stirring in soap making also affected the high and/or low pH of the resulting soap preparation (Hasibuan *et al.*, 2019). The average pH test in FI was 6.01, the average pH test in FII was 6.06, and the average pH test in FIII was 6.10. According to research conducted by Ermawati (2023), varying SLS concentrations in each formula caused an increase in pH to become alkaline. This is because the surfactant used can increase pH. Although the pH of each formula experienced an increase, the soap preparation was still included in the pH testing standard so that when applied to the skin, it did not cause irritation and dry skin. The pH test results were then tested for normality using the Shapiro-Wilk method, obtaining a sig. > 0.05, indicating normality. The homogeneity test was then performed using the Test of Homogeneity of Variance, which obtained a sig. > 0.05, indicating homogeneity of the data. The data were then statistically analysed using ANOVA and obtained a sig value (0.000) < 0.05, which indicates a significant effect on pH testing due to variations in the concentration of SLS as a surfactant. These test results are supported by Chasani *et al.* (2022), who explained that variations in the concentration of SLS can affect the physical properties, such as the pH, of soap preparations.

The foam height test is used to determine the foaming ability of hand soap. The foam height standard according to SNI is 13-220 mm. The foam height test results for the three formulas are shown in Table 2. Based on the table above, it shows that the foam height of each replication experienced an increase in foam height. This is because during shaking it still uses a manual method, so the speed and time cannot be adjusted. This causes the foam height results to fluctuate (Wulandari *et al.*, 2024). The average foam height test in FI is 47 mm, the average foam height in FII is 54 mm and the average foam height in FIII is 60 mm. The increase in foam height test results between formulas depends on the concentration of SLS (Sodium Lauryl Sulphate) used; the higher the concentration of SLS (Sodium Lauryl Sulphate) used, the more and more stable the foam produced. The results of this study are supported by Ermawati (2023), who explains that the addition of SLS (Sodium Lauryl Sulphate) can increase foam height. The foam height test results for hand soap showed good foam height, as they were within the foam height testing standards. The foam height test data were then tested for normality using the Shapiro-Wilk test, yielding a sig. >0.05, indicating normality. The homogeneity test, followed

by a test of homogeneity of variance, yielded a sig. >0.05 , indicating homogeneity. The data were then statistically analysed using ANOVA, yielding a sig. $(0.002) < 0.05$, indicating a significant effect on foam height due to variations in the concentration of SLS (Sodium Lauryl Sulphate) as a surfactant. These test results align with research by Chasani *et al.* (2022), which explains that variations in SLS concentration can affect the physical properties of soap preparations, such as foam height.

The viscosity test is used to determine the thickness of a soap. The standard viscosity test for hand soap is 400-4000 cPs. The results of the soap viscosity test are shown in Table 2. Based on the table above, the average viscosity test for FI is 805 cPs, the average for FII is 821.66 cPs, and the average for FIII is 846.33 cPs. The increase in viscosity test results is caused by variations in SLS (Sodium Lauryl Sulphate) concentration; if the concentration is greater, the soap preparation will be thicker. This is in line with research conducted by Ermawati (2023), where variations in SLS (Sodium Lauryl Sulphate) affect the physical properties of the preparation, namely viscosity. The results of the handwashing soap viscosity test have a good viscosity value because it is still included in the viscosity testing standard. The viscosity test data were then tested for normality with Shapiro-Wilk and obtained a sig result > 0.05 , which means the data is normal. Continued with the homogeneity test with the test of homogeneity of variance, obtaining a sig result > 0.05 , which means the data is homogeneous. The data were then statistically analysed using ANOVA and obtained a sig value $(0.000) < 0.05$, which means there is a significant effect on viscosity testing due to variations in the concentration of SLS as a surfactant. These test results are in accordance with research by Marlina *et al.* (2022), which explains that the addition of varying SLS affects the physical properties in the form of the viscosity of soap preparations.

4. CONCLUSION

Variations in SLS concentration affect the results of organoleptic tests, pH, viscosity, and foam height which show significant differences (sig $< 0,05$) between FI, FII, and FIII, but in the homogeneity test results, variations in SLS concentration do not affect the results of the homogeneity test which shows no significant difference (sig $> 0,05$) between FI, FII, and FIII.

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