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TESTING THE ACTIVITY AND FORMULATION OF NATURAL HAND SOAP BASED ON NATURAL SURFACTANTS OF LERAK FRUIT (*Sapindus rarak* DC.) AGAINST *Staphylococcus aureus*

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ABSTRACT

Lerak (*Sapindus rarak* DC.) is a fruit belonging to the *Sapindaceae* family that usually grows in tropical forests. Lerak fruit flesh contains the main active compound, saponin. Saponin is a natural surfactant with foaming and emulsifying properties. The use of synthetic surfactants in the manufacture of hand soap sold on the market can have negative impacts, such as irritation and denaturation of proteins in the outer epidermis layer in humans if exposed too often. This study aimed to determine whether lerak can be formulated into natural hand soap as a natural surfactant and determine its antibacterial activity against *Staphylococcus aureus* bacteria. Lerak fruit solutions were prepared using a maceration method. The resulting solution was then formulated into hand soap at concentrations of 10%, 30%, and 50%. The evaluation of the natural hand soap preparation from the lerak fruit included organoleptic evaluation, homogeneity, pH, viscosity, foam height, and antibacterial activity against *Staphylococcus aureus* bacteria using the disc diffusion method. Based on the research results, Lerak Fruit (*Sapindus rarak* DC.) can be formulated as a natural surfactant in hand soap at concentrations of 0%, 10%, 30%, and 50%. Based on the evaluation of the physical properties in the foam height test, F1, F2, and F3 met the requirements, whereas F0 did not meet the requirements in the foam stability test because it did not contain lerak fruit extract, so no foam formed. Results of the antibacterial activity test of lerak fruit (*Sapindus rarak* DC.) hand soap preparations against the growth of *Staphylococcus aureus* bacteria with a concentration of F1 (4.42 mm) had a weak inhibitory power, F2 (9.50 mm) had a moderate inhibitory power, and F3 (13.68 mm) had a strong resistance.

Keywords: Natural Hand Soap, Lerak, Surfaktan

INTRODUCTION

People have long used soap products to clean dirt and stains in their bodies and clothes. As technology develops, various types of soap appear in the market. Until now, people have had the highest interest in liquid soap because of its various advantages such as ease of use, practicality, hygiene, and inability to be easily damaged or dirty (Cahyaningsih *et al.*, 2019). Since ancient times, people have used plants as ingredients for making soap, one of which is the lerak plant used to wash batik cloth (Muttafaq *et al.*, 2020).

Lerak (*Sapindus rarak* DC.) is a fruit belonging to the *Sapindaceae* family that usually grows well in tropical climates. Lerak contains phytochemical compounds, such as alkaloids, tannins, flavonoids, and polyphenols. Lerak fruit flesh also contains saponin, the main active compound. Saponin functions as a natural surfactant with foaming and emulsifying

properties (Chen *et al.*, 2010). The saponin content in lerak fruit is higher than that in hibiscus leaves, which makes batik washed using lerak fruit produce an unchanged color even after a long time (Muttafaq *et al.*, 2020).

Surfactants are among the main components of hand soaps. In the manufacture of hand soap and conventional soap, many currently still use synthetic surfactants in the form of phosphates, alkyl benzene sulfonates, diethanolamines, and alkyl phenoxy. All of these compounds come from non-renewable resources (petroleum) and are toxic and dangerous to the environment. Synthetic surfactants are reported to have a negative impact, causing irritation and denaturation of proteins in the outer epidermal layer in humans if exposed too often (Agustina & Wuryanto, 2008). Based on these negative impacts, it is necessary to use natural surfactants to replace synthetic surfactants, one of which is the use of the natural surfactant, lerak fruit.

Lerak fruit contains phytochemical compounds as antibacterial substances that can inhibit and kill microbial growth (Wijayanti *et al.*, 2020a). According to Silviani & Puspitaningrum (2021), lerak boiled water has antibacterial activity against pathogenic *Escherichia coli*. This is also supported by Widowati *et al.* (2022), who demonstrated the phytochemical compounds and antibacterial activity of the ethanol extract of lerak fruit (*Sapindus rarak*) against three bacteria that cause nosocomial infections. *Sapindus rarak* DC is active against *Staphylococcus aureus* bacteria (Riza & Oktavia, 2018).

The aim of this study was to determine how to formulate lerak fruit as a natural surfactant in hand soap and to determine its antibacterial activity against *Staphylococcus aureus* bacteria.

RESEARCH METHODS

The type of research that will be carried out is experimental research in the laboratory, making several hand soap formulas containing lerak fruit extract (*Sapindus rarak* DC), and the quality of the preparations was checked by evaluating their physical properties and antibacterial effectiveness against *Staphylococcus aureus* bacteria.

Equipment and Materials

The equipment used in this research included a digital scale (Fujitsu FSR-A 300), autoclave (ALP Ogawa Seiki), incubator (France Etuves), laminar airflow (Miniheli II), Brookfield viscometer (NDJ-5S), and pH meter (AS218). The materials used in this study were lerak fruit, CMC sodium, nipagin, sodium benzoate, tryptic soy agar (TSA), tryptic soy broth (TSB), Dettol® liquid soap, and *Staphylococcus aureus*. The ingredients used in the formulation met pro-analysis specifications.

Research Procedure

1. **Preparation of Lerak Fruit Extract**

   Lerak fruit extract was extracted using the maceration method, with 96% ethanol as the solvent. Lerak fruits that had been cut into small pieces were weighed up to 50 mg and then soaked in 50 mL of 96% alcohol. The immersion extraction process for 2 weeks was carried out with the aim of optimizing the process of separating active compounds in lerak fruit (Widowati *et al.*, 2022).

2. **Hand Soap Formulation from Lerak Fruit**

   Na CMC is developed with 20x water by sprinkling it on hot water then letting it sit for 30 minutes until it swells. Mix Na CMC with a solution of lerak fruit (*Sapindus rarak* DC.) by stirring gently. Then, sodium benzoate was added, which was dissolved in hot water and fragrance (Wijayanti *et al.*, 2020a).

Table I. Hand Soap Formulation from Lerak Fruit

Material	Concentration (%)				Utility
	F0	F1	F2	F3	
Lerak fruit	0	10	30	50	Active substances and surfactants
Na CMC	5	5	5	5	Gelling agent
Sodium benzoate	0,2	0,2	0,2	0,2	Preservative
Fragrance	1	1	1	1	Fragrance
Water ad	100	100	100	100	Solvent

3. Evaluation of Hand Soap from Lerak Fruit

a. Organoleptic Evaluation

Organoleptic testing was performed by visually observing the texture, smell, and color of the hand soap (Fatkhil *et al.*, 2022).

b. Homogeneity Evaluation

After preparing approximately 0.5 grams of hand soap, the hand soap was rubbed onto the glass surface to test its homogeneity of the hand soap. This test was designed to assess the physical uniformity of hand soap throughout the object. If there are no lumps or large grains in any component of the hand-soap mixture, the mixture is considered homogeneous (Fatkhil *et al.*, 2022).

c. Evaluate pH

The pH was determined using a pH meter. The calibrated pH meter electrode was dipped into a solution prepared for evaluation, which was made from 1 gram of hand soap diluted with 10 mL of distilled water (Sainbanu *et al.*, 2023).

d. Viscosity Evaluation

Hand soap viscosity was measured using a Brookfield Viscometer and spindle number 3 at 60 rpm. The container containing the hand soap sample was installed, the spindle was installed, and the rotor was installed. Viscosity measurements were recorded immediately after the results were displayed (Rosmainar, 2021).

e. Foam Stability Evaluation

The ability and stability of the foam were determined using the cylinder shake method; the sample was weighed at 1 g, put into a test tube, added with distilled water to 10 mL, shaken by turning the test tube 10 times, and the height of the foam produced was immediately measured. The tube was left for 5 minutes, then the height of the foam produced was measured again after 5 minutes (Rahayu *et al.*, 2020).

$$\% \text{ Foam lost} = \frac{Initial\ foam\ height - final\ foam\ height}{Initial\ foam\ height} \text{ x } 100\ \%$$

$$\text{Foam stability} = 100\% - \%\ \text{foam lost}$$

4. Antibacterial Activity Test

The antibacterial activity of the hand soap was tested using a disc diffusion test against *Staphylococcus aureus* bacteria. New bacterial cultures were prepared by inoculating one colony of the test organisms in tryptic soy broth (TSB) at 37°C for 24 hours. Bacterial inoculum (0.2 mL) was evenly spread on tryptic soy agar (TSA) media. Hand soap (10, 30, and 50 mg/mL) was pipetted into sterile paper discs measuring 6 mm. The paper discs were dried in laminar air flow before being transferred to a TSA-containing bacterial inoculum. Dettol® liquid soap was used as a positive control and sterile distilled water was used as a negative control. Incubate at 37°C for 24 hours. The tests were performed in triplicate. The presence or absence of inhibition zones was observed and recorded during the incubation period (Lourdes *et al.*, 2023).

RESULTS AND DISCUSSION

Lerak fruit was obtained from plantations located in Kaur Regency, Bengkulu Province. The Lerak fruit used was cut into small pieces to break down the cell walls and expand the surface of the Lerak fruit flesh so that the compounds contained in the Lerak fruit, especially saponin, can dissolve in the solvent (Sari *et al.*, 2022). Lerak fruit was extracted using the maceration method with 96% ethanol as the solvent. The maceration process was carried out for 2 weeks with the aim of optimizing the process of separating active compounds in lerak fruit (Wijayanti *et al.*, 2020b).

Figure 1. Lerak fruit extract

Figure 2. Hand soap from lerak fruit

Seven tests were carried out at the preparation testing stage: organoleptic observations (including shape, color, and odor), homogeneity, pH testing, viscosity, foam stability, hedonics, and antibacterial activity.

Table II. Organoleptic Results of Lerak Fruit Hand Soap

Organoleptic	F0	F1	F2	F3
Smell	No smell	The distinctive aroma of lerak fruit	The distinctive aroma of lerak fruit	The distinctive aroma of lerak fruit
Form	Condensed	Condensed	Condensed	Condensed
Color	White	Brown	Brown	Brown

Organoleptic tests with visual observations carried out for 4 weeks showed that there were no changes in any of the preparations, including changes in shape, color, and aroma. In F0, the preparation was white because it did not contain fruit extract. Testing the homogeneity of lerak fruit hand soap preparations showed that F0, F1, F2 and F3 were homogeneous without any grains or coarse granules when observed visually on glass (Nailufa, 2020).

Table III. pH Results of Lerak Fruit Hand Soap

Concentration	Average
F0	8.07
F1	8.83
F2	8.52
F3	8.21

pH testing was performed to determine the pH of the liquid soap. The average pH values obtained for the four formulations were 8.07, 8.83, 8.52, and 8.21, respectively. This pH value meets the requirements for liquid soap according to SNI in the range of 8–11 (Rosmainar, 2021). The results of this test indicated that the higher the concentration of the extract, the lower the pH in the formula. This is because lerak fruit has acidic properties that can affect the pH of each formula. Mukhopadhyay *et al.* (2018) and Dita *et al.* (2020) explained that the pH of the soapnut solution (*Sapindus* group) decreases as the concentration of soapnut increases, and the concentration of H^+ ions also increases. An increase in H^+ ions causes a decrease in the pH value.

Table IV. Viscosity Results of Lerak Fruit Hand Soap

Concentration	Average
F0	532.11
F1	542.19
F2	579.18
F3	601.93

When testing the viscosity of the four lerak fruit hand soap formulas, the averages were 532.11, 542.19, 579.18, and 601.93. The viscosity value of the formula meets the Indonesian National Standard (SNI) for liquid soap viscosity, with a minimum of 500 cP and a maximum of 20,000 cP (Rosmainar, 2021). The results of the viscosity test showed that the higher the concentration of lerak fruit extract, the higher the viscosity, which is due to the increase in surfactant concentration where the surfactant in this study is saponin from the lerak. According to Fatkhil *et al.* (2022), the viscosity increases as the concentration of lerak fruit extract increases, which causes the preparation to become thicker, resulting in an increase in viscosity.

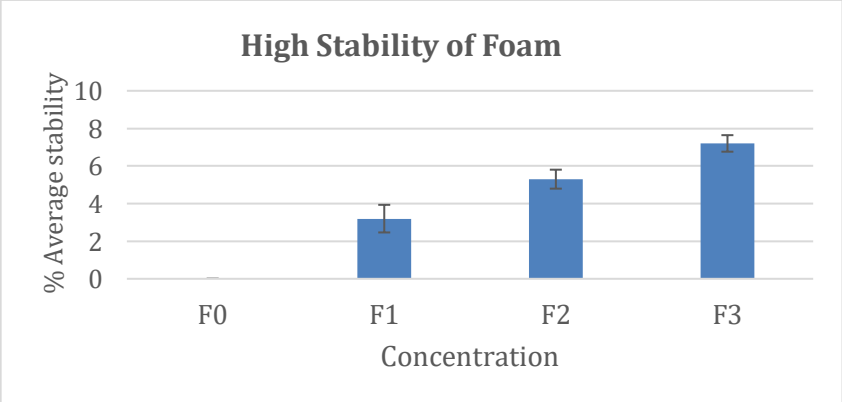

Figure 3. High stability of foam results of lerak fruit hand soap

In testing the stability of the lerak fruit hand soap foam, the average % stability results for each formula were 71.55% - 90.55%, thus meeting the criteria for good foam stability. The results show that the higher the extract concentration in the soap preparation, the higher the foam produced because the height of the foam is influenced by the saponin contained in lerak fruit (Rahayu *et al.*, 2020). This is in accordance with previous research, where the

stability of lerak soap foam is classified as high because it has a value of more than 50% (Dita *et al.*, 2020). At F0, no foam was formed because it did not contain lerak fruit extract, which functioned as a foam-producing surfactant.

Table V. Antibacterial Activity Results of Lerak Fruit Hand Soap

Concentration	Replication (mm)						% Average stability
	1		2		3		
	0'	5'	0'	5'	0'	5'	
F0	0	0	0	0	0	0	0
F1	4,8	3,3	4,1	3	4,4	3,2	71,55 ± 0,73
F2	6,5	5,3	6,2	5,6	6,1	5,3	86,24 ± 0,51
F3	8	7,4	8,3	7,4	8	7,2	90,55 ± 0,44

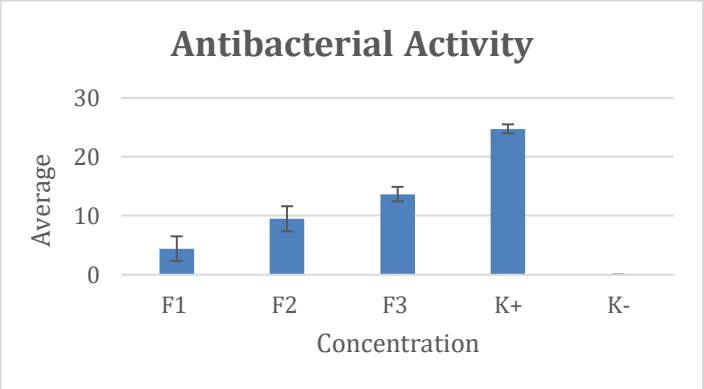

Figure 4. Antibacterial activity results of lerak fruit hand soap

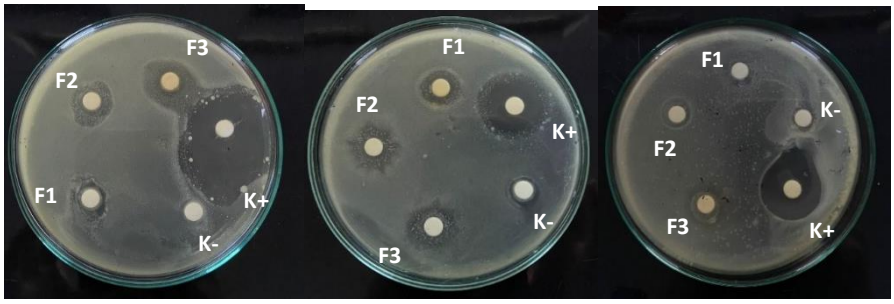

Figure 5. Testing of the antibacterial activity of lerak fruit hand soap

The antibacterial activity of lerak fruit hand soap was tested using the disc diffusion method. This test was carried out using *Staphylococcus aureus* bacteria and Dettol® soap as a positive control where Dettol® soap is a marketed soap that is used as an antibacterial soap. The selection of test microbes was based on the purpose of using lerak fruit hand soap as an antibacterial soap, where *Staphylococcus aureus* bacteria are gram-positive bacteria with normal flora on the skin (Silviani & Puspitaningru, 2021). Antimicrobial inhibition zone activity was grouped into four categories: weak activity (< 5 mm), moderate (6–10 mm), strong (11–20 mm), and very strong (> 20–30 mm) (Winastri *et al.*, 2020). Based on the test results, the inhibition zone produced in F1 was included in the weak inhibition zone category, F2 in the medium category, F3 in the strong category, and the positive control in the very strong inhibition zone category. In general, the increase in the diameter of the extract inhibition zone on bacterial activity increases as the concentration of the extract increases (Lourdes *et al.*, 2023). The antibacterial activity of the ethanol extract of lerak fruit is caused by the phytochemical content contained, based on qualitative phytochemical tests it was found that the contents of the ethanol extract of lerak fruit (*Sapindus rarak*) are flavonoids, alkaloids, saponins, tannins, quinones, steroids and terpenoids (Riza & Oktavia,

2018). The high saponin compounds in lerak fruit can work by increasing cell membrane permeability and reducing cell surface tension. This allows the entry of antibacterial substances through the bacterial cell walls, resulting in hemolysis of bacterial cells (Ugha *et al.*, 2019).

CONCLUSION

Based on the research results, Lerak Fruit (*Sapindus rarak* DC.) can be formulated as a natural surfactant in hand soap at concentrations of 0%, 10%, 30%,, and 50%. Based on the evaluation of the physical properties in the foam height test, F1, F2, and F3 met the requirements, whereas F0 did not meet the requirements in the foam stability test because it did not contain lerak fruit and thus no foam formed. Results of the antibacterial activity test of lerak fruit (*Sapindus rarak* DC.) hand soap preparations against the growth of *Staphylococcus aureus* bacteria with a concentration of F1 (4.42 mm) had a weak inhibitory power, F2 (9.50 mm) had a moderate inhibitory power, and F3 (13.68 mm) had a strong resistance.

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