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FORMULATION AND ACTIVITY TESTING OF TRANSPARENT SOLID SOAP WITH ETHANOL EXTRACT OF PINEAPPLE FRUIT PEEL (*Ananas comosus (L) Merr*) AGAINST *Staphylococcus aureus* BACTERIA

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Abstract
The pineapple fruit (Ananas comosus (L) Merr) has medicinal properties as a traditional remedy. The pineapple fruit peel is rich in active compounds such as flavonoids, bromelain enzyme, and vitamin C, which are known for their antibacterial properties. This activity is more effective when incorporated into soap formulations. Soap that can kill bacteria is known as antiseptic soap. In this study, the extract of pineapple fruit peel is used to determine whether it can be formulated into a transparent solid soap and to determine the concentration of the extract that meets the requirements for physical evaluation and stability testing of the transparent solid soap formulation. The research is conducted as an experiment by making transparent solid soap. The pineapple fruit peel is extracted using the maceration method with 96% ethanol as the solvent. The obtained extract is then used to create a transparent solid soap formulation with concentrations of 0.5% (F1), 1.0% (F2), and 1.5% (F3) of the pineapple fruit peel extract. This formulation is evaluated through physical evaluation, which includes organoleptic testing, pH testing, foam height testing, water content testing, hardness testing, free alkali number testing, cycling test, and antibacterial activity testing. The antibacterial activity testing shows that all formulations of transparent solid soap with pineapple fruit peel extract can inhibit the growth of Staphylococcus aureus bacteria, with the largest inhibition zone observed in F3 with a diameter of 26.8 mm against Staphylococcus aureus bacteria.

Introduction

The most important and influential organ on a human's appearance is the skin. The skin serves the function of protecting the internal organs from external disturbances and threats. This function is carried out by forming a keratin layer, facilitating respiration, regulating body temperature, and producing melanin pigment that is beneficial in shielding the body from ultraviolet rays. If the skin is injured, it becomes susceptible to infections. Infections caused by such wounds provide a pathway for microorganisms or germs to enter the human bloodstream. Skin infections can be caused by bacteria, viruses, protozoa, and other types of microorganisms (1).

The skin is found in the epidermis layer, often referred to as the stratum corneum layer. This stratum corneum is composed of intracellular lipids that release oil called sebum. Sebum is used to maintain the moisture and smoothness of the skin. However, sebum can mix with dirt on the skin and stick to it, so it needs to be removed. Additionally, the skin also requires protection from various dangerous pathogenic bacteria, hence the need for protection to avoid these pathogenic bacteria. One way to remove dirt mixed with sebum and protect against pathogenic bacteria is by using soap (1)

Transparent solid soap is one of the soap innovations that makes soap more appealing. Transparent soap produces a smoother lather compared to opaque soap, which is not transparent. Soap is a mixture of sodium compounds with fatty acids used as a body cleanser in solid form, producing foam, with or without other additional substances, and does not cause skin irritation (2).

The primary ability of transparent solid soap as a cleanser alone may not be sufficient to make it attractive from a marketing perspective if it is not accompanied by more specific benefits. Therefore, active ingredients are needed that can provide dual benefits in transparent soap, in addition to the cleansing agent, by functioning as a free radical scavenger and preventing bacterial and microbial infections. One of the ingredients with antibacterial properties is pineapple fruit peel extract (3).

The ethanol extract of pineapple fruit peel was analyzed for its compound groups using color tests with specific reagents for each compound test. The positive result of the ethanol extract of pineapple fruit peel indicates the presence of secondary metabolites such as flavonoids, saponins, tannins, and alkaloids. In the flavonoid testing, the identification result showed a color change in the solution to red, indicating that the ethanol extract of pineapple fruit peel is positive for containing flavonoid compounds (4).

Based on previous research, the extract of pineapple fruit peel has a greater antibacterial effect against Staphylococcus aureus compared to the extract of its fruit pulp. Furthermore, another study mentions that ethanol extract of pineapple fruit peel in hand sanitizer formulations is capable of inhibiting the growth of Staphylococcus aureus. Hand sanitizer formulations with pineapple fruit peel extract at concentrations of 0.5%, 1%, and 1.5% each resulted in inhibition zones against Staphylococcus aureus measuring 10mm, 15mm, and 15.5mm, respectively (5)

The extract of pineapple fruit peel in dishwashing soap formulations has proven to be highly effective in inhibiting the growth of Staphylococcus aureus. Dishwashing soap formulations at concentrations of 10% (FI), 20% (FII), and 30% (FIII) resulted in inhibition zones against Staphylococcus aureus measuring 13mm, 15mm, and 19.3mm, respectively. Formula FIII with 30% concentration exhibited the largest bacteria inhibition zone. These research findings demonstrate the capability of pineapple fruit peel to inhibit the growth of Staphylococcus aureus, making it suitable for use in dishwashing soap (6).

The antibacterial activity of pineapple fruit peel extract against Staphylococcus aureus was determined by measuring the diameter of inhibition zones. The ethanol extract of pineapple fruit peel at concentrations of 0.5%, 1.0%, and 1.5% exhibited inhibition zones of 10.0mm, 15.0mm, and 15.5mm, respectively, against Staphylococcus aureus. This demonstrates that the pineapple fruit peel extract, using the maceration method, is capable of inhibiting the growth of Staphylococcus aureus (7).

Materials and Methods

This type of research is a laboratory experimental study using the disc diffusion method. The sample used is the dried powdered pineapple fruit peel (Ananas comosus (L) Merr). A total of 500g of dried crude powder was extracted using the maceration method with 96% ethanol as the solvent. The maceration process was carried out for 3x24 hours in a place protected from sunlight and occasionally stirred. Then, the macerated material was filtered, and the collected filtrate was saved. The residue was subjected to maceration again using 96% ethanol for 3 days. The collected filtrate was then evaporated using a "rotary evaporator" at a temperature of 50°C and 50 rpm, until a concentrated ethanol extract of pineapple fruit peel was obtained.

The soap-making process was carried out through heating and stirring using a spirit lamp. Virgin coconut oil (VCO) and the pineapple fruit peel extract, as variables, were heated and stirred until the temperature reached approximately 65°C. Then, NaOH dissolved in distilled water was added to initiate the saponification process. Melted stearic acid was added to the mixture. Next, 96% ethanol was added to dissolve the hardening mixture, and after dissolving, glycerin, sugar solution, and triethanolamine were added to the mixture, followed by the addition of orange oil. The heating and stirring process were continuously carried out until all ingredients were dissolved. The temperature was maintained at approximately 65°C. Once a layer formed on the top of the mixture, the transparent soap was ready to be molded.

The data collected from the evaluation of the transparent solid soap preparation in terms of organoleptic test, pH test, foam height test, free alkalinity test, soap moisture content, irritation test, and antibacterial test will be presented in the form of tables. Subsequently, for the analysis of the inhibitory activity of the preparation, One Way ANOVA will be used.

Results

A total of 500 grams of pineapple fruit peel was extracted using 5 liters of 96% ethanol, resulting in 63.06 grams of thick extract with a yield percentage of 12.6%. The extract is greenish-yellow in color and has a distinctive pineapple aroma. In this study, formulations of solid transparent soap were prepared with several concentrations, namely F0 (without pineapple fruit peel extract), F1 0.5%, F2 1.0%, and F3 1.5% addition of pineapple fruit peel extract.

Table-1. Yield data obtained

Extract	Colour	Aroma	Weight of crude drug (g)	Weight of extract (g)	Percentage yield (%)
Pineapple fruit peel	Greenish-yellow	Distinctive pineapple aroma	500	63.06	12.6%

Table 2 show the research results indicate that soap with a pineapple fruit peel extract concentration of 0% (without the addition of pineapple fruit peel extract) has the highest transparency. Subsequently, the concentrations of 0.5% and 1.0% show lower transparency, and the soap with a concentration of 1.5% pineapple fruit peel extract appears to be the most turbid.

Table-2. Data from the organoleptic evaluation of transparent solid soap formulation with pineapple fruit peel extract (Ananas comosus (L) Merr)

Formula	Before cycling test			After cycling test		
	Colour	Aroma	Texture	Colour	Aroma	Texture
F0	clear transparent	Orange oil	solid	clear transparent	Orange oil	solid
F1	Transparent greenish-yellow	Orange oil	solid	Transparent greenish-yellow	Orange oil	Solid
F2	Transparent yellowish-brown	Orange oil	solid	Transparent yellowish-brown	Orange oil	solid
F3	Slightly transparent yellowish-brown	Orange oil	solid	Slightly transparent yellowish-brown	Orange oil	solid

The results obtained from the pH testing show that the formulations made without the addition of pineapple fruit peel extract have the following average pH values: F0 (without

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extract) has a pH of 10.8, formula 1 has an average pH of 8.8, formula 2 has an average pH of 9.9, and formula 3 has an average pH of 10.5.

Table-3. Data from the pH test of transparent solid soap formulation with pineapple fruit peel extract (Ananas comosus (L) Merr)

Formula	pH Test		Average pH	Standard SNI 3532-2016 (BSN, 2016)
	Before cycling test	After cycling test		
F0	11.0	10.6	10.8	9-11
F1	9.5	8.1	8.8	
F2	10.4	9.5	9.9	
F3	10.6	10.5	10.5	

Table 4 show the results of the foam height testing for solid transparent soap with pineapple fruit peel extract in the formulations showed the following average values: F0 - 30 cm, F1 - 19 cm, F2 - 10.5 cm, and F3 - 8.6 cm. The foam height requirement according to SNI (cm) 3532-2016 is 1.3-22 cm

Table-4. Data from the testing of foam height of solid transparent soap formulation with pineapple fruit peel extract (Ananas comosus (L) Merr)

Formula	Foam Heigh Test				Average foam height	Standard SNI 3532-2016 (BSN, 2016)
	Before cycling test		After cycling test			
	Initial foam height (cm)	After 5 minutes	Initial foam height (cm)	After 5 minutes		
F0	6	4	7	5	33,3 + 28,5 =30	1.3 - 22
F1	7	6	5	4.5	14,2 + 25 =19	
F2	6	5	4.4	4	11,1 + 10 =10,5	
F3	6	5.5	4	3	8,3 + 9 = 8,6	

The antibacterial testing in this study was conducted using the disc diffusion method. K-care soap was used as the positive control, and soap base was used as the negative control. The results of the antibacterial testing showed that F1, F2, F3, and the positive control exhibited very strong inhibitory responses against Staphylococcus aureus bacteria.

The inhibition zones for the soap formulas containing 0.5%, 1.0%, and 1.5% pineapple fruit peel extract were 24.6mm, 25.2mm, and 26.8mm, respectively. The positive control showed an inhibition zone of 30.3mm against Staphylococcus aureus bacteria.

Table-5. Data on the results of antibacterial activity testing of solid transparent soap formulation with pineapple fruit peel extract (Ananas comosus (L) Merr)

Formula	Zone of inhibition diameter (mm)			Average zone of inhibition diameter (mm)	Category	Zone of inhibition category parameters
	Replication					
	1	2	3			
F0	-	-	-	-	Weak	<5mm (weak)
K+	29.7	30.8	30.4	30.3	Very strong	5-10 mm (sedanng)
F1	24.6	24.6	24.7	24.6	Very strong	10-20 mm (kuat)
F2	24.8	25.3	25.7	25.2	Very strong	>20 mm (sangat kuat)
F3	26.6	25.9	25.7	26.5	Very strong	

DISCUSSION

The results of the organoleptic evaluation show that the use of pineapple fruit peel extract affects the color and transparency level of the solid transparent soap. The higher the concentration of pineapple fruit peel extract, the lower the transparency level of the solid transparent soap. pH measurement is used to indicate the acidity or alkalinity level of a solution. If a formulation is outside the skin's pH range, it may cause flaky skin or even irritation. On the other hand, if it is above the skin's pH range, it may feel slippery, dry quickly, and affect skin elasticity. The solid transparent soap produced in this study has a pH that meets the requirements and is safe to use on the skin (5).

The pH testing results indicate that the formulations made without the addition of pineapple fruit peel extract have the following average pH values: F0 (without extract) has a pH of 10.8, formula 1 has an average pH of 8.8, formula 2 has an average pH of 9.9, and formula 3 has an average pH of 10.5. As the concentration increases, the pH value also increases. According to ASTMD1172-95 (2001), the safe pH range for soap is 9-11, while SNI 3532:2016 states that the safe pH range for soap is between 8-11. pH values that are too high can increase skin absorption, leading to skin irritation and dryness. pH is related to the amount of free alkali (8)

From the statements above, it can be concluded that the foam stability produced by each soap in each treatment is good (9). The foam height test is one of the most important parameters in determining the quality of cosmetic products, especially soap. The purpose of the foam height test is to evaluate the foaming ability of solid transparent soap. Stable foam is desired as it helps in effective body cleansing. The characteristics of soap foam are influenced by several factors, including the presence of surfactants, foam stabilizers, and other ingredients in the formulation of solid transparent soap. These factors play a significant role in determining the quality and stability of the foam produced by the soap(10).

The higher the concentration, the harder the soap becomes. The hardness of the soap is also influenced by the concentration of stearic acid and sucrose used. The higher the concentration of stearic acid and sucrose, the greater the hardness of the resulting soap. Additionally, the hardness of the soap increases every week after storage due to the saponification reaction, which reaches completion after 2 weeks of storage (6).

The hardness test of soap is affected by the water content present in the soap. The higher the water content, the softer the soap becomes. The hardness of the soap is also influenced by the presence of saturated fatty acids in the soap. To make the soap harder, stearic acid is added to the formulation. Furthermore, the duration of the curing process of the soap in the mold also affects the level of hardness of the resulting soap.

Comparatively, the hardness of solid transparent soap in the market has a penetration value ranging from 21.30 10-1 mm to 25.80 10-1 mm. Hardness is a mechanical measurement of the resistance of a soap bar to physical pressure. Soap bars typically have a specific level of hardness. Softer soaps have higher penetration values. The hardness of the soap plays a role in increasing the soap's efficiency during use. Harder and more solid soaps generally have a longer shelf life than softer soaps(11).

The hardness of soap is influenced by the saturated fatty acids used in soap production. Saturated fatty acids are fatty acids that do not have double bonds and have a higher melting point compared to fatty acids with double bonds. Saturated fatty acids tend to solidify at room temperature, resulting in harder soap. Additionally, the hardness is also affected by the water content of the soap. The higher the water content, the softer the soap

The antibacterial testing in this study was conducted using the disc diffusion method. K-care soap brand was used as the positive control, and soap base was used as the negative control. The results of the antibacterial testing showed that F1, F2, F3, and the positive control exhibited very strong inhibitory responses against Staphylococcus aureus bacteria(6).

The inhibition zones for the soap formulas containing 0.5%, 1.0%, and 1.5% pineapple fruit peel extract were 24.6mm, 25.2mm, and 26.8mm, respectively. The positive control showed an inhibition zone of 30.3mm against Staphylococcus aureus bacteria. Staphylococcus aureus bacteria tend to be more sensitive to antibacterial components. The structure of the cell wall of Gram-positive bacteria (Staphylococcus aureus) is relatively simpler, making it easier for antibacterial compounds to enter and find their targets for action. The antibacterial compounds in the soap show maximum activity in inhibiting bacteria due to the soap's hydrophilic-lipophilic nature, allowing it to interact with both water and oil, making it effective against a broad range of bacteria (12).

Conclusion

Based on this research, it can be concluded that pineapple fruit peel extract can be formulated into solid transparent soap. Furthermore, the formulation of solid transparent soap with pineapple fruit peel extract can inhibit the growth of Staphylococcus aureus bacteria, providing additional value to the soap.

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