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Formulation and Antibacterial Activity Testing of Eco-Soap Based on Sodium Lauryl Sulfate Surfactant

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Abstract

Pineapple is a fruit that is often used only for its flesh, while the skin remains waste. As a form of dealing with pineapple waste, one way is to use it as an eco-enzyme. Making soap with added eco-enzyme can be used as an alternative for washing dishes. Therefore, this research aims to determine the formulation and test the antibacterial activity of eco-soap based on the surfactant Sodium Lauryl Sulphate. This research is experimental research, which was carried out in July-October 2023. The research results showed that the pH of eco-Soap was 3.46; foam height 1.5 cm; viscosity testing 14.9 mPas; fatty acids 1.44%; and 6 mm antibacterial activity testing. Based on the research results, it was concluded that the surfactant-based eco-soap formulation had good stability in the eco-soap foam height test. The diameter of the zone of inhibition of eco-soap's antibacterial activity showed that bacterial inhibition was moderate.

Keywords: Eco-enzyme; Eco-Soap; Antibacterial; Pineapple Waste; Formulation.

INTRODUCTION

Indonesia is the fourth largest country in the world as a pineapple producer. In 2019, Indonesia's pineapple production reached 2,196,456 tons, increasing by 21.7% from 2018. One of the largest pineapple-contributing provinces is Lampung (Astoko, 2021).Pineapples are commonly utilized for their fruit flesh, while their peel often becomes waste. Therefore, efforts to address pineapple waste need to be considered, one of which is by utilizing it to produce eco-enzymes, with the hope that it can be developed into Eco-Soap.

The shift in dishwashing behavior, moving away from the use of scrubbers, has an impact on soap consumption. While soap may not be a primary need, the frequency of soap usage is relatively high. This is due to the main function of soap, which is to clean dirt, and it offers practical, hygienic, and economic advantages (Akyuni et al., 2021; Sianiar et al., 2021).

The fulfillment of dish soap needs sparks ideas and opportunities for product creation. With the advancement of technology, synthetic soaps from various brands have flooded the market. However, the current trend is shifting towards organic options due to their environmentally friendly nature (Duraisamy et al., 2011; Jadid et al., 2020), One of the ingredients that can be added in the making of dish soap is eco-enzyme (Iswati et al., 2021). Eco-enzyme is a liquid fermentation derived from organic waste such as vegetables and fruits, and it possesses various benefits (Hasanah, 2021). The fermentation process is carried out using molasses or palm sugar, allowing it to sit for a minimum of 3 months, with the lid being opened once a week. (Larasati et al., 2020).

Eco-enzyme demonstrates antibacterial activity; the acetic acid content in eco-enzyme can eliminate germs, bacteria, and viruses. It has the ability to eradicate bacteria such as S. Typhi, S. aureus, C. Albicans, and viruses (Anisa et al., 2022), It also significantly suppresses the growth of Escherichia coli (Ginting et al., 2021). The phenolic compounds present in eco-enzyme will interact with the cell walls of microorganisms, leading to the denaturation of proteins. This causes a structural change in proteins, and the increased permeability of the cell, resulting in the inhibition of bacterial cell growth (Rusdianasari et al., 2021). The production of soap with the addition of eco-enzyme can be considered as an alternative for dishwashing. Therefore, this research aims to determine the formulation and test the antibacterial activity of eco-soap based on Sodium Lauryl Sulfate surfactant.

MATERIALS AND METHODS

Materials

This research was conducted at the Laboratory of FMIPA UNILA from July to October 2023. The equipment used for making eco-soap (eco-enzyme dishwashing soap) included rulers, pipettes, buckets, pH meters, Erlenmeyer flasks, pycnometers, titration tools, round-bottom flasks, stirrers, and test tubes. The materials used included Eco-enzyme, Escherichia coli bacteria, Nutrient Agar, coloring agents, phenolphthalein solution, Nutrient Broth (NB), texapon, perfume, thickener, 96% ethanol, 0.1 N HCl, distilled water, boiling stones, SLS, NaCl, and preservatives (Sianiar et al., 2021).

Procedures

- Formulation of Surfactant-Based Eco-Soap Prepare a solution of texapon (100 g, eco-enzyme 50 ml, water 400 ml), then add SLS (50 g, water 200 ml, 50 ml eco-enzyme). Mix NaCl (50 g) with water (200 ml) and eco-enzyme (50 ml) while stirring until thickened and free from lumps. Add fragrance, and then conduct quality tests for eco-soap, including pH measurement, foam height testing, fatty acid testing, and viscosity testing.
- Antibacterial Activity Test The antibacterial activity test of surfactant-based eco-soap is conducted for 6 hours on a 30 ml solution against Escherichia coli bacteria.

RESULTS AND DISCUSSION

Result

Testing the pH of Eco-Soap

The pH measurement of eco-soap resulted in an acidic pH category (Table 1)

Table 1. Eco-Soap pH Testing.

Quality Testing	Conclusion
pH	3,46

Foam Height Testing of Eco-Soap

The results of the eco-soap foam height test obtained a foam height of 1.5 cm, meeting the criteria for good soap (Table 2)

Table 2. Eco-Soap Foam Height Testing.

Quality Testing	Conclusion
Foam Height	1,5 cm

Viscosity Testing

The viscosity test results showed a viscosity of 14.9 mPas (Table 3).

Table 3. Viscosity Testing.

Quality Testing	Conclusion
Viscosity	14,9 mPas

Fatty Acid Testing

The results of the fatty acid test indicate a value of 1.44% (Table 4).

Table 4. Fatty Acid Testing.

Quality Testing	Conclusion
Fatty Acid	1,44%

Antibacterial Activity Test

The results of the antibacterial activity test show a measurement of 6 mm (Table 5).

Table 5. Antibacterial Activity Testing.

Quality Testing	Conclusion
Antibacterial Activity	6 Mm

Discussion

This research was conducted from July to October 2023, utilizing the Integrated Laboratory and Technology Innovation Center of Lampung University. The study design employed was experimental. Variables observed in this research included pH measurement, foam height testing, fatty acid testing, viscosity testing, and antibacterial testing against *Escherichia coli* bacteria.

The research involved the production of eco-enzyme over a 3-month period, followed by the manufacture of eco-soap or dishwashing soap. The cleaning base used was a combination of anionic and nonionic surfactants, specifically Sodium Lauryl Sulfate (SLS). The use of SLS serves as the primary ingredient for forming foam (surfactant source) in liquid dishwashing soap. This surfactant produces a dishwashing base with good foam stability and low potential for irritation. The addition of eco-enzyme in eco-soap functions as an antibacterial agent, providing a potential solution to combat bacteria on household utensils

The characterization observation results for pH indicate a category below 4, meeting the standard for good eco-enzyme production (Putra & Suyas, 2022), The low production of eco-enzyme is attributed to the high content of organic acids. The results of this research align with previous studies, indicating that eco-enzyme is chemically acidic with a pH between 3 – 4 (Rochyani et al., 2020), This is supported by the research (Rasit et al., 2019) The higher the content of organic acid, the lower the pH of the eco-enzyme product, as organic acid serves as the pH acidity indicator. The organic acid found in the eco-enzyme product is generated through a 3-month fermentation process. The presence of acetic acid in the eco-enzyme has also been identified by this research (Samriti & Arya, 2019) That there is acetic acid in eco-enzyme, although the concentration of acetic acid in eco-enzyme is not as high as in vinegar, is supported by the research (Larasati et al., 2020) Acetic acid is produced through the metabolic process of bacteria naturally present in fruit and vegetable residues. The anaerobic metabolism process, commonly known as fermentation, is an effort by bacteria to obtain energy from carbohydrates under anaerobic conditions, resulting in by-products such as alcohol or acetic acid. Fungi and certain bacteria produce alcohol during fermentation, while most bacteria produce acetic acid. It can be concluded that eco-enzyme has a low pH due to its high content of organic acids, namely citric acid and acetic acid. (Etienne et al., 2013).

PH testing of eco-soap is one of the quality requirements for dishwashing soap or eco-soap. The pH value indicates the acidity level of a substance. pH is a crucial indicator for eco-soap to determine its suitability and safety for use on the skin, as eco-soap comes into direct contact with the skin and can cause issues if the resulting pH does not match the skin's pH. A pH value that is too low can cause skin irritation, while a pH that is too high can result in dry or flaky skin. The pH testing of eco-soap involves diluting 1 ml of the soap to be examined with distilled water up to 10 ml. The solution is then placed in a calibrated pH meter, and the pH meter is observed until it stabilizes, indicating a constant pH value. Based on observations of the soap preparation from eco-enzyme, it was found that the pH of eco-soap is 3.46. The national standard for the pH of dishwashing soap or eco-soap, according to the SNI-2588-2017 standard, states that good dishwashing soap should have a pH value between 6 and 11. This indicates that the eco-soap in the conducted research does not yet meet the established national standard for dishwashing soap. The reason for this discrepancy is that the eco-enzyme used as an ingredient in eco-soap has an acidic pH derived from citrus, resulting in the produced eco-soap having an acidic pH (Arrazi et al., 2021).

The foam height test is conducted to determine the amount of foam remaining after a certain period. Foam is a colloidal system with a dispersed gas phase and a medium dispersing liquid substance. The dispersed gas phase is typically air or CO2. Foam stability is achieved through the presence of surfactants. Surfactants have hydrophilic and hydrophobic groups. The hydrophilic group binds with water molecules, while the hydrophobic group moves towards the solution's surface, facing the air.When the water and surfactant solution is stirred or exposed to air, air bubbles emerging from the liquid body will be coated by a thin layer of liquid containing surfactants, forming foam. One of the appealing features of soap is its foam content. Foam stability is expressed as the resistance of a bubble to maintain its size or prevent the rupture of the film layer.The examination of foam height is one method to control the stability of liquid soap in producing foam. The higher the foam stability value, the higher the quality of the produced foam. Foam stability is significantly influenced by the particle size, so the greater and larger the particle size, the lower the foam stability. If the foam produced is abundant and stable, it will be preferred by consumers compared to foam that is scarce and unstable (Rosmainar, 2021). The foam height test begins by diluting 2 ml of eco-soap with 10 ml of distilled water, which is then placed into a test tube. Subsequently, the mixture is shaken for 20 seconds and allowed to stand for 5 minutes. The height of the formed foam is then measured using a ruler, resulting in a foam height of 1.5 cm or 15 mm. The standard for soap foam height set by the Indonesian National Standard (SNI-2588-2017) is 13-220 mm. Therefore, the eco-soap meets the criteria for good soap as its foam height falls within the specified range.

Viscosity testing is used for the analysis of the thickness of liquid dishwashing soap or eco-soap formulations. Dishwashing soap has a standard viscosity range according to the Indonesian National Standard (SNI) of 400-4000 mPas. Viscosity measurements of eco-soap formulations using eco-enzyme as the base material are conducted with a Haake viscometer. A 150 ml sample is prepared in a 250 ml beaker, and the spindle is adjusted before being immersed in the formulation until the viscometer indicates the viscosity value of the formulation. The result obtained is 14.9 mPas, which does not meet the SNI standard. The research findings are below commercial soap, possibly due to a lack of added thickening agents or excessively high water content.Eco-soap formulations with too low viscosity can disrupt solution stability, leading to separation, while formulations with excessively high viscosity can slow the flow rate of the soap solution. Additionally, the formation of an overly concentrated gel system may occur (Yuli Handayani et al., 2022).

Free fatty acids are fatty acids present in the eco-soap sample but are not bound as potassium compounds or triglyceride compounds (fats/oils). Free fatty acids still exist in eco-soap because they have not undergone saponification reactions. The testing of free fatty acids is done through titration. 5 ml of liquid soap is placed in an Erlenmeyer flask. Then, 100 ml of 96% methanol is added. The mixture is heated to boiling, and it is titrated with 0.1 N HCl until the pink color disappears, using phenolphthalein as an indicator. The result of the free fatty acid testing in eco-soap using eco-enzyme as the base material is 1.44%. According to the Soap Quality Standard (SNI 2588: 2017), good soap should have a free fatty acid content not exceeding 0.1%. Therefore, eco-soap does not meet the criteria for soap with good free fatty acid levels.Free fatty acids are associated with the soap's odor. If the free fatty acids exceed the soap standard, it can result in a rancid odor and hinder the cleaning process of the skin surface by the soap (Verawaty et al., 2020).

Antibacterial activity testing is conducted to determine whether the dishwashing soap formulation can inhibit the growth of Escherichia coli. If the bacterial inhibition zone is < 5 mm, it indicates weak antibacterial activity. If the diameter of the inhibition zone ranges from 5 to 10 mm, the activity is considered moderate. If the diameter of the inhibition zone ranges from 10 to 20 mm, it indicates strong antibacterial activity. And if the diameter of the inhibition zone produced is > 20 mm, it indicates very strong antibacterial activity. The observation result for the inhibition zone diameter of eco-soap after a 6-hour incubation period with a concentration of 30 ml is 6 mm, categorizing it as having moderate inhibitory activity. This means that eco-soap with eco-enzyme as the main ingredient shows good results in inhibiting the growth of Escherichia coli bacteria.

The mechanism of bacterial inhibition by eco-enzyme is attributed to the presence of flavonoid and tannin contents acting as bioseptans. The flavonoid content in the eco-enzyme inhibits nucleic acid synthesis, interferes with cell membrane function, and hinders energy metabolism. Additionally, the antibacterial content exhibits activities related to its capability to activate microbial cell adhesion, enzyme activation, and disruption of protein transport in the inner layers of the cell (Rahayu et al., 2021). The antibacterial activity of eco-enzyme is likely related to its content of acetic acid and lactic acid. Organic acids can inhibit and kill microorganism growth through a mechanism in which dissociated and ionized molecules flow through the microorganism cell membrane. To maintain intracellular pH, hydrogen ions are released, and the acidic pH causes cell deformation, damaging enzymatic activities, proteins, and bacterial DNA structures, ultimately leading to extracellular membrane damage. In another mechanism, changes in membrane permeability can hinder substrate transportation, while changes in intracellular pH can suppress NADH oxidation. This can affect the electron transport system, leading to organism death (Andam, 2017).

CONCLUSIONS

Based on the research findings, it can be concluded that the formulation of eco-soap based on surfactants exhibits good stability in the high foam test. However, in the pH test, viscosity test, and fatty acid test, the results did not meet the standards. The diameter of the inhibition zone for the antibacterial activity of surfactant-based eco-soap against *Escherichia coli* bacteria indicates a moderate inhibitory effect.

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