RiCE: Research in Chemical Engineering
Volume 2. No 1, 2023
Journal homepage: https://ejournal.ump.ac.id/index.php/rice

Application of Saponins from Ambon Banana Petiole (*Musa paradisiaca var. sapientum L.*) as Natural Surfactants in Bio-Hand Soap

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Article Info

Submit:
5 July 2023

Revision:
10 August 2023

Accepted:
11 August 2023

First Online:
13 August 2023

ABSTRACT

Surfactants are commonly use as a foaming agents contained in soap products. Consequently, the type of surfactant used is a synthetic product that is difficult to degrade by nature fate. In addition to environmental problems, prolonged use of these products can cause health problems, such as irritation in the form of dry, scaly, itchy skin, to red rashes. Synthetic surfactants used in industry are also petroleum derivatives. This fact makes the sustainability of the industry threatened due to the increasingly critical oil reserves. Based on these problems, it is important to study alternative synthetic surfactants that are more environmentally friendly, safe for health, and abundantly available in nature. In this study, the potential of saponins from the petiole of the Ambon banana (*Musa paradisiaca var. sapientum L.*) was studied as a natural surfactant in hand soap (bio-hand soap). The purpose of this study was to study the effect of the variable concentration of ethanol solvent and immersion time on the amount of saponin extract yield and the formulation of bio-hand soap. The results showed that the highest extract yield of Ambon banana petiole extract could be achieved using ethanol solvent at a concentration of 80% and a maceration time of 48 hours. Based on the quality tests on bio-hand soap products that have been carried out, formula 1 (20% saponins), 2 (30% saponins), and 3 (40% saponins) have color, shape, anti-bacterial agent, and pH values that are following SNI 2588:2017. The formula that is considered the most optimum for the production of bio-hand soap is Formula 2. This is based on the highest foam stability value, which is 67.56%.

Keywords: Saponins, Ambon banana petiole, bio-hand soap

1. INTRODUCTION

Surfactants are molecules that have a polar group that dissolves easily in water (hydrophilic) and a non-polar group that dissolves in oil (lipophilic). This causes surfactants to unite a mixture consisting of oil and water [1]. Surfactant materials are generally used in soap products as foaming agents. The type of synthetic surfactant that is currently often used is the type of Sodium Lauryl Sulfate (SLS) or Sodium Lauryl Ether Sulfate (SLES). The surfactant is a synthetic chemical that is difficult to be degraded by nature. Based on literature data it is known that the content of phosphate and surfactant in soap waste is 9.9 mg/L., 10.1 mg/L [2]. This value exceeded the maximum threshold set by the Minister of Environment through PERMENLH No 10/1995, namely 3 mg/L and 5 mg/L for phosphate and surfactant levels. In addition to environmental problems, the use of high-dose and prolonged use of SLS and SLES products can have an impact on health. The problem that is often experienced is irritation in the form of dry, scaly, itchy skin, to a red rash. Synthetic surfactants used in industry are also compounds derived from petroleum. This fact causes the sustainability of the soap industry to be threatened due to the increasingly critical oil reserves. Referring to the existing problems, it is important to study alternatives to synthetic surfactants that are more environmentally friendly, safe for health, and whose raw materials are abundantly available in nature.

Alternative materials to replace synthetic surfactants in liquid soap proposed in this study are saponins. Saponin is a glycoside that has an aglycone in the form of sapogenin [3]. Saponins are known to be spread in almost every part of the plant body, such as roots, stems, tubers, leaves, seeds, and fruit. The test results showed that the highest concentration of saponins was contained in parts that were susceptible to attack by insects, fungi, or bacteria [4]. This shows that saponins play a role in the plant body's defense system. Chemically, saponins are composed of glycosides which have an aglycone in the form of sapogenins. This chemical structure causes saponins to have the ability to lower the surface tension of water, resulting in the formation of froth-like surfactants.

The potential of saponins as natural surfactants has been carried out several times, for example, star fruit saponins [5], saponins of senggon leaves [6], waru leaf saponins [7], and so on. The results of the study by Damayanti [8] showed that detergents containing saponins from avocado seeds have anti-bacterial properties. Based on the results of this study, it can be concluded that saponins have the potential to replace synthetic surfactants in soap products.

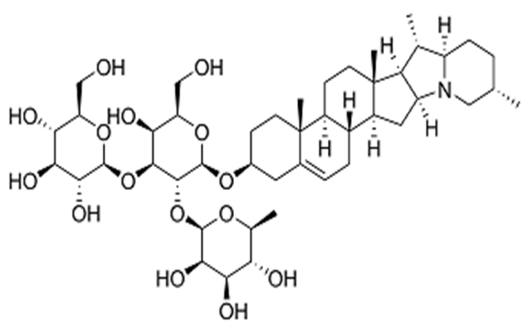

Figure 1. Saponin Structure

Saponins in this study were isolated from the midrib of the Ambon banana (Musa paradisiaca var. sapientum L.). Research on saponins from banana leaf waste was conducted by Suharto [9]. The results showed that the methanol extract of Ambon banana stems contained steroid-type saponins. However, this study has not studied further regarding the use of saponins. In this study, saponins from the midrib of the Ambon banana were extracted using ethanol as a solvent. Saponins are then used as surfactants in the formula for hand washing soap (bio-hand soap). The focus of this research is to determine the optimum conditions for the saponin extraction process with ethanol solvent and also the optimal composition of saponin extract in bio-hand soap. To optimize the saponin extraction process, variations were made on the variable concentration of ethanol solvent and soaking time. In the manufacture of bio-hand soap, variations are made on the number of saponins to produce liquid soap with characteristics according to SNI 2588:2017.

2. MATERIALS AND METHODS

2.1 Materials

Alcohol (Merck, pa), Sodium Lauryl Sulfate (SLS) (technic), Cocoamide DEA (technic), NaCl (Merck), Methylparaben (technic) Propilenglikol (Merck, pa), Na2HPO4 (Merck, pa), NaH2PO4 (Merck, pa), Aquades (Bratachem). Banana petiola were taken from community gardens in Purwokerto City, Banyumas.

2.2 Methods

2.2.1 Sample Preparation

Banana fronds are washed with running water until clean. Then it was sliced thinly with a thickness of 1 mm and dried in an oven at 50°C for 24 hours. Dried banana fronds are ground in a blender to produce banana frond powder or simplicial. After that, the banana frond powder or simplicial is sieved using a 100 mesh sieve so that the resulting sample is finer, making the extraction process easier.

2.2.2 Extraction of Banana Stems and Optimization of Operational Variables

The banana frond seed powder was weighed as much as 10 grams and put into a beaker glass, then immersed in ethanol solvent with a solid/liquid ratio of 1:5 (w/v). During the maceration process, manual shaking was carried out every 12 hours for 5 minutes so that the extract was still mixed with the solvent. The extract obtained was then separated between the filtrate and the residue using a vacuum filter. The filtrate was then evaporated using a rotary evaporator at a pressure of approximately 200 mBar, a rotational speed of 60 rpm, and a temperature of 40°C for 10 minutes. Evaporation is stopped when all the solvent has evaporated which is indicated by the absence of solvent vapor droplets. The viscous extract obtained was put into a sample bottle. Saponin yield was measured by UV-Vis spectrophotometry and gravimetric method. To obtain optimal extraction conditions, the ethanol concentration was varied to 75%, 80%, and 85%. Immersion time varied into 24 hours, 36 hours, 48 hours, and 60 hours.

Table 1. Table of Hand Washing Soap Formulations

Material	Formulas (% of saponin)			
	Control	Formula 1 (20%)	Formula 2 (30%)	Formula 3 (40%)
Banana Stem Extract	0	20	30	40
Sodium Lauryl Sulfate (SLS)	10	0	0	0
Cocoamide DEA	2	2	2	2
NaCl	1	1	1	1
Methyl paraben	0,1	0,1	0,1	0,1
Propilenglikol	1	1	1	1
Na_2HPO_4	2,46	2,46	2,46	2,46
NaH_2PO_4	0,08	0,08	0,08	0,08
Aquades	73,36	63,36	53,36	43,36

2.2.3 Manufacturing of Bio-hand soap.

The saponin extract that has been produced in the next stage is mixed with supporting ingredients, namely: Cocoamide DEA, NaCl, Methylparaben, Propylenglykol, Na_2HPO4, NaH_2PO4, and distilled water according to the composition shown in **Table 1**. Determination of the number of ingredients other than the ethanol extract of Ambon banana stem and SLS was determined based on the experiment of Ikhrom and modification according to SNI standard 2588:2017.

2.2.4 Bio-hand soap formulation

The saponin extract that has been successfully isolated is then formulated according to **Table 1**. to produce Bio-hand soap. The bio-hand soap formed is then characterized to measure the quality of the soap produced compared to the standard liquid hand sanitizer set by SNI 06-2588-2017.

2.2.5 Yield analysis

The yield is the quotient of the weight of the product (extract) produced divided by the weight of the raw material multiplied by 100%.

yield (%) =W1/W2x100% (1)

Where, W1 = weight of Ambon banana stem extract, W2 = weight of Ambon banana stem powder.

2.2.6 Foam Stability Determination

Foam stability is assessed by calculating the ratio between foam height and total height (solution+foam). Foam stability is calculated by looking at how long the foam is formed (minutes).

2.2.7 Organoleptic Test

This is done by subjectively looking at the color, shape, and aroma of the bio-hand soap.

2.2.8 Viscosity Test

A viscosity test is used to measure and analyze the level of viscosity of bio-hand soap using the viscosity meter (Brookfield DV2TRV)

2.2.9 pH Test

The pH test is used to measure the level of acidity or alkalinity of bio-hand soap.

2.2.10 Biological Oxygen Demand (BOD)

Biological Oxygen Demand (BOD) shows the amount of dissolved oxygen needed by microorganisms to decompose or decompose organic matter under aerobic conditions.

2.2.11 Antibacterial characteristic test

The antibacterial effectiveness test was carried out by the diffusion method against *E. coli* bacteria.

3 RESULTS AND DISCUSSION

3.1 Identification of Ambon Banana Petiole Saponin Extract in Ethanol Solvent

Saponin pada pelepah pisang ambon telah berhasil diekstraksi dengan using ethanol as a semi-polar solvent. Ethanol was chosen in this study because it has the same polarity level (around 5.2) as flavonoids, saponins, polyphenols, and tannins which are derivatives of polyphenolic compounds with several hydroxyl groups [10]. Chaerunnisa stated that soaking saponins with ethanol causes the breakdown of the cell wall which causes compounds in the cytoplasm to dissolve in the solvent. The dissolved saponins were then identified by UV-vis spectrophotometer and foam test. The results of the identification of saponins with a Uv-vis spectrophotometer are shown in **Figure 2.**

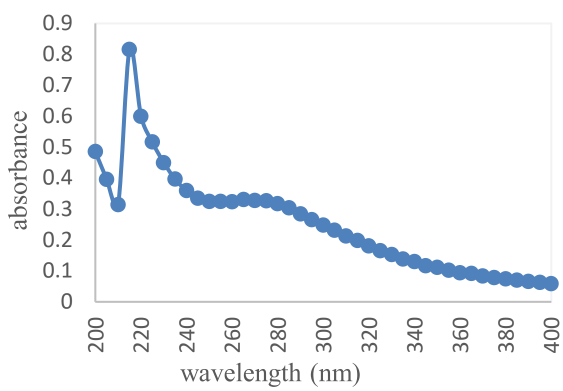

Figure 2. Determination of the Maximum Wavelength of Saponins in Ambon Banana Stem Extract

The graph in **Figure 2** shows that the maximum wavelength of saponins from banana leaf extract is 215 nm with an absorbance value of 0.816. The wavelength value is not much different from Rachman's research [11]. The results show that saponins have a maximum wavelength of saponins at 211 nm with an absorbance of 3.65. Based on the research data and literature study, it can be concluded that saponins from the banana stem have been successfully extracted.

In this study, stable foam was formed with a height of 2 cm for 30 seconds. Saponins from the Ambon banana fronds have better height and stability than the split uli fronds studied by Rikomah [12]. In that study, samples of banana uli fronds produced foam with a height of 0.5 cm and lasted 30 seconds. Meanwhile, Calbiochem saponins produce foam with a height of 3 cm lasting 60 minutes.

3.2 Determination of the Effect of Ethanol Concentration Variable on the Total Yield of Saponin Extract (%)

The next research stages are directed at optimizing the ethanol concentration variables and soaking time. The first variable to be optimized is the ethanol concentration. The yield value of the Ambon banana stem extract is shown in **Table 2.**

Table 2. Yield (%) of Ambon banana stem extract

Ethanol Concentration	Time		
	24 hours	48 hours	72 hours
75 %	34,30	35,04	36,04
80 %	42,84	50,20	37,30
85 %	24,22	27,70	23,90

Table 2 shows that the concentration of ethanol affects the yield of saponins. The results showed that the highest extract yield in Ambon banana stem extract could be achieved by using ethanol solvent with a concentration of 80% and maceration time for 48 hours. The saponin yield value obtained in these conditions was 50.2%. The lowest yield of saponin extract of 23.90% was obtained when the extraction was carried out with 85% ethanol and the maceration time was 72 hours.

Literature studies show that the higher concentration of the solvent causes a decrease in the polarity of the solvent which is a mixture of ethanol and water, which in turn can increase the ability of the solvent to extract compounds that are less polar, such as saponins [13]. Less polar solvents can cause cell walls that have less polar properties to be degraded so that the active compounds present in the sample become easier to extract [14]. This theory is suitable to explain the phenomenon in research results which show an increase in the yield of saponins when the ethanol concentration is increased from 75% to 80%. Increasing the concentration of ethanol to 85% decreased the yield of saponins obtained.

3.3 Determination of the Effect of Soaking Time Variable on the Total Yield of Saponin Extract (%)

The longer extraction time will increase the number of broken cells and dissolved active ingredients [15]. This condition will continue until an equilibrium condition is reached between the concentration of compounds in the banana leaf and the concentration of compounds in the solvent. Data **Table 2**. Shows that the optimum point is reached at 48 hours of maceration time. The addition of contact time to 72 hours was no longer effective in increasing the extract yield. Cikita stated that extraction times that exceed optimum conditions have the potential to increase the process of loss of compounds such as essential oils in solution due to evaporation by heat [16]. Diputri's research shows that solvent concentration and extraction time are directly proportional to yield. On the other hand, a solvent concentration that is too concentrated and the maceration time exceeds the optimum conditions can result in saturation and damage to the desired compound.

Table 3. Organoleptic Testing of Bio-Hand Soap Preparations

Sample	Color	Form	pH	Foam Stability (%)
Control	Clear, Colorless	Homogeneous liquid	7	85,71
Formula 1	Slightly Brown	Homogeneous liquid	7	62,85
Formula 2	Clear Brown	Homogeneous liquid	8	67,56
Formula 3	Clear brown, more concentrated than Formula 2	Homogeneous liquid	8	66,67

3.4 Organoleptic Test and Foam Stability

The organoleptic test aims to determine the physical appearance of the preparation by looking at the shape, aroma, and color.

Figure 3. Organoleptic Test of Bio-hand Soap Preparations

Figure 3 shows that the more banana stem extract the color of the product becomes, the darker brown it becomes. The resulting liquid soap is in the form of a homogeneous liquid and has a distinctive perfume scent. The results of organoleptic, pH, and foam stability tests on bio-hand soap preparations are shown in **Table 3**.

Table 3 shows that the pH of various bio-hand soap formulas ranges from 7-8. This shows that the pH range of Bio-hand soap complies with that required by SNI, namely 4-10.

The foam test was carried out to find out how long the resulting foam was stable. Foam is said to be stable if it has a stability value of around 60-70% [17]. The results of the study (**Table 3**) showed that increasing the number of saponins from 20% to 30% in formulations 1 and 2 was able to increase foam stability from 62.85% to 67.56%. Increasing the number of saponins up to 40% reduced the stability of the foam to 66.67%. Based on the foam test, the best formula is formula 2.

3.5 Analysis of BOD and COD of Bio-Hand Soap Waste

Analysis of BOD and COD content from bio-hand soap waste was carried out to measure the level of environmental friendliness of soap products. The test results showed that bio-hand soap waste had a COD value of 82 mg/L and a BOD value of 0.2 mg/L. This value is following the standard of the allowable quality standards for domestic wastewater based on Minister of Environment and Forestry Regulation Number 68 of 2016 concerning Quality Standards for Domestic Wastewater, namely BOD content not exceeding 30 mg/L and COD content not exceeding 100 mg/L.

3.6 Bio-Hand Soap Antibacterial Test

Antibacterial effectiveness test of Bio-hand soap ethanol extract of Ambon banana stem on E. coli bacteria using the diffusion method. This method looks at the sensitivity of bacteria to antibacterial agents which is indicated by the formation of inhibition zones around the wells. The results of the antibacterial activity test of the ethanol extract of the Ambon banana stem showed antibacterial activity on the growth of E. coli in the strong inhibition zone category. The results of testing the antibacterial properties of bio-hand soap are shown in **Table 3.**

4 CONCLUSION

Ethanol concentration and soaking time affect the yield of saponins. The results showed that the highest extract yield in Ambon banana stem extract could be achieved by using ethanol solvent with a concentration of 80% and maceration time for 48 hours. Based on the quality test on bio-hand soap products that has been carried out, formula 1 (20% saponin), 2(30% saponin), and 3 (40% saponin) have color, shape, and pH values that comply with SNI standards. The formula that is considered the most optimum is Formula 2. This is based on the highest foam stability, which is 67.56%. The results of the research that have been described show that saponins from banana stems have potential as natural surfactants which are not only environmentally friendly but also have anti-bacterial properties. The results of the characterization of the bio hand soap preparations that were tested also showed compatibility with the characteristics of hand washing liquid soap according to SNI standard 2588: 2017.

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