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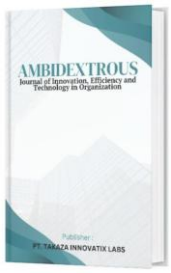

Synthesis and Characterization of Solid Soap Based on Avocado Seed Oil (Persea Americana) with the Addition of Betel Leaf Extract (Piper Betle) as a Natural Antiseptic Active Ingredient

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Abstract: *The increasing public demand for safe antiseptic soap has encouraged the development of natural products as an alternative to synthetic antiseptics, which have been associated with skin irritation and bacterial resistance. This study aims to synthesize solid soap from avocado seed oil (Persea americana) with the addition of betel leaf extract (Piper betle) and to evaluate its physical characteristics and antibacterial activity. A laboratory experimental study with a completely randomized design was conducted using two soap formulations with avocado seed oil to betel leaf extract ratios of 2:1 (F1) and 4:1 (F2). The soap was produced through saponification and tested for organoleptic properties, pH, foam height and stability, and antibacterial activity using the well diffusion method against Staphylococcus aureus and Escherichia coli. Both formulations successfully produced solid soap with pH 10, solid texture, and yellowish cream to golden yellow color. Foam stability was 70.0% for F1 (2:1) and 72.7% for F2 (4:1). The 4:1 ratio formulation showed better physical quality with higher foam stability and more homogeneous appearance. [**Note:** Antibacterial activity results should be added here once data is available, e.g., "Antibacterial testing showed inhibition zones of X mm against S. aureus and Y mm against E. coli."] Avocado seed oil and betel leaf extract have potential as raw materials for environmentally friendly natural antiseptic soap with good physical characteristics, with the 4:1 oil-to-extract ratio recommended for optimal soap quality..*

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Introduction

Soap is a basic human need for maintaining personal hygiene. As public awareness of the importance of hygiene increases, demand for antiseptic soap products is also increasing. However, most antiseptic soaps on the market use synthetic active ingredients such as triclosan and alcohol. Continuous use of synthetic ingredients has been linked to a number of side effects, including skin irritation, microbial imbalance, and bacterial resistance. This has led to the need to develop more natural, safe, and environmentally friendly soap products.

Soap is used by all age groups in society, from young to elderly, to cleanse the skin of impurities. Based on its form, soap is classified as solid or liquid. According to Hambali et al. (2005), solid soap is classified based on its transparency: opaque, translucent, and transparent.(Turangan et al., 2023a)

One potential approach is to utilize natural ingredients with antibacterial activity. Betel leaves (Piper betle) are widely known in traditional medicine as a natural antiseptic. Active compounds such as eugenol, chavicol, and tannins in betel leaves have been shown to have antimicrobial effects against various types of pathogenic bacteria. Betel leaf extract has been widely used in products such as mouthwash, feminine cleansers, and wound antiseptics.

There are two types of betel leaves: red betel leaves and green betel leaves. Green betel leaves are known to have antibacterial effects against several types of bacteria. Green betel leaves contain essential oils, the main components of which are phenols and their derivatives. One of these derivatives is kavikol, which has a bactericidal effect five times stronger than phenol. Meanwhile, red betel leaves are a potential medicinal plant, empirically known to have properties to cure various types of diseases.(Anas & Puspitasari, 2018).

On the other hand, avocado production in Indonesia is relatively high and has been widely used in various types of food and beverage processing. However, utilization generally focuses only on the flesh of the fruit, while other parts, such as the skin and seeds, are often neglected and end up as organic waste. Avocado seeds themselves are quite large and consist of two fused pieces, enclosed by a hard seed coat. The physical structure and chemical composition of avocado seeds indicate that this waste actually has utility, for example as a base ingredient for functional food products, natural dyes, or even as a raw material for pharmaceuticals and cosmetics after undergoing certain extraction and processing processes.(Zagita et al., 2021.)Avocado seed oil (Persea americana) is a source of unsaturated fatty acids and vitamin E, which have emollient and antioxidant properties and help maintain skin moisture. The use of avocado seed oil not only enriches natural soap formulations but also supports the sustainable management of agricultural waste.

Given the potential of each of these ingredients, the combination of avocado seed oil as a soap base and betel leaf extract as an active antiseptic is an interesting approach to explore. This formulation is expected to produce a solid soap that is safe for the skin and more environmentally friendly than antiseptic soaps made from synthetic chemicals. With the right knowledge and skills, avocado seeds can be processed into environmentally friendly products such as natural soap, which not only have high sales value but can also raise public awareness of the importance of waste management and environmental sustainability.

However, to date, research on the use of avocado seed oil as a soap base with the addition of betel leaf extract is still limited. Therefore, this study is important to explore the potential of combining these two natural ingredients to produce a solid soap with effective antibacterial activity and good physicochemical characteristics.

Formulation of the problem

1. What is the procedure for synthesizing solid soap from avocado seed oil with the addition of betel leaf extract?
2. How does the variation in the ratio of avocado seed oil: betel leaf extract (ratio 4:1 and 2:1) affect the physical characteristics of soap (texture, color, pH, homogeneity, and foaming power)?
3. Does the addition of betel leaf extract in both ratios increase the antibacterial activity of the soap?

Research purposes

1. Describe and document the steps for making solid soap based on avocado seed oil with the addition of betel leaf extract.

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1 Evaluate the effect of oil:extract ratio (4:1 and 2:1) on the physical characteristics of soap (pH, texture, color, homogeneity, and foaming power).
2 Assessing the antibacterial effectiveness of soap formulations.

1.4 Significance of the Research

This research was conducted to develop a solid soap made from natural ingredients that is safer to use and has a lower environmental impact. Using avocado seed oil as the base ingredient and betel leaf extract as a natural antibacterial agent, this research is expected to provide an alternative to chemical-based antiseptic soaps that can potentially cause irritation or bacterial resistance. Furthermore, utilizing avocado seeds, which are usually wasted, also provides added value from a sustainability perspective. The expected benefits of the soap are moisturizing and nourishing the skin. The results of this research are expected to form the basis for developing more skin-friendly hygiene products and supporting the use of local resources.

Literature review

Solid Soap

Soap is a chemical product commonly used in everyday life. Soap making has been practiced for thousands of years, dating back to ancient Roman times, around 2,300 BC. Early soap making involved heating a mixture of fat and wood ash. Furthermore, in Europe, soap was primarily used for medicinal purposes in the 16th and 18th centuries. It wasn't until around the 19th century that its use began to become widespread.(Eka Mareta Winanti & Br Gultom, 2024.).

Soap is the result of a saponification reaction between fat or oil and a strong base, such as NaOH, producing fatty acid salts and glycerol. This process is the basis for making solid soap. The addition of ingredients such as ethanol, glycerin, and sugar solution can produce high-quality, transparent soap.

According to the 1994 Indonesian National Standard (SNI), bath soap is defined as a sodium compound with fatty acids used as a body cleanser, in solid form, foaming, with or without other additives and does not cause skin irritation. The quality requirements for solid bath soap stipulated by SNI are that solid soap has a maximum water content of 15%, a maximum free alkali content of 0.1% and a free fatty acid content of less than 2.5%.

Solid soap is a cleaning product that is chemically the sodium salt of fatty acids produced through a chemical process called saponification.

Figure 1. Solid Soap

Avocado Seed Oil

Avocado seeds consist of 65% flesh (mesocarp), 20% seed (endocarp), and 15% pericarp (rind). According to Prasetyowati, avocado seeds contain 15–20% oil. Avocado seeds contain almost the same amount of oil as soybeans, making them a suitable source of vegetable oil. Avocado seed oil can be obtained through extraction or pressing methods. The extraction method results in less oil loss during the process, resulting in a higher yield of oil.(Risyad et al., 2016).

Avocado seed oil is a vegetable oil extracted from the seeds of the avocado fruit (Persea americana). This oil contains various unsaturated fatty acids, such as oleic acid (C18:1) and linoleic acid (C18:2), as

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well as bioactive compounds like vitamin E, phytosterols, and natural antioxidants, which provide cosmetic and skin health benefits.

Avocado seed oil's rich unsaturated fatty acid content makes it a suitable raw material for making solid soap with moisturizing and nourishing properties. This oil also has potential antibacterial activity, supporting the soap's function as a cleanser and protecting the skin from pathogenic microorganisms.

In soap making, avocado seed oil serves as a source of triglycerides, which react with NaOH during the saponification process to produce soap with the desired physical and chemical characteristics. Previous research has shown that soap formulated with avocado seed oil has a soft texture, stable lather, and good antibacterial activity against both Gram-positive and Gram-negative bacteria.

Avocado seed soap offers numerous benefits, including being rich in skin-beneficial nutrients like flavonoids and unsaturated fatty acids, which help maintain moisture and prevent premature signs of aging. Antioxidants like polyphenols also help protect the skin from free radicals that can damage skin cells. Furthermore, this soap is environmentally friendly because it utilizes avocado seed waste, thus helping reduce organic waste. Economically, utilizing avocado seeds as a raw material also opens up new business opportunities for the community by improving skills in processing local materials into high-value products.(Dwi Larasati et al., 2024).

Figure 2. Avocado Seed Oil

Betel Leaf Extract

Betel leaves (Piper betle L.) are a traditional medicine containing catechins and tannins, which are polyphenolic compounds. Betel leaves are commonly used as an antiseptic, a substance used to kill or prevent the growth of microorganisms. Betel leaves also contain saponins, flavonoids, and polyphenols. Saponins can act as antimicrobials. These compounds damage the cytoplasmic membrane and kill cells. Flavonoids are thought to denature bacterial cell proteins, irreparably damaging the cell membrane.(Illiyyin Akib et al., 2024).

The antibacterial properties of green betel leaf extract have been proven by Sumampouw's (2008) research, in vitro testing of the antibacterial activity of betel leaves (Piper Betle L), showed that a mixture of 96% ethanol could inhibit the growth of Escherichia coli bacteria. It was also proven by Saraswati's (2011) research, the effect of betel leaf extract concentration on the inhibition of Escherichia coli, and the minimum concentration of extract that was able to inhibit Escherichia coli bacteria was found at a concentration of 50%.

The antibacterial effect of the green betel plant is due to the essential oil content of the green betel leaves, the main component of which consists of phenol and several derivatives, including eugenol and kavikol, which have antibacterial properties.(Pinatik et al., nd)

Betel leaf extract obtained through extraction methods with ethanol or water solvents contains high concentrations of phenolic compounds and essential oils that effectively inhibit the growth of various pathogenic bacteria, including Staphylococcus aureus and Escherichia coli. Betel leaf extract (Piper betle L.) is known to have significant antibacterial activity, making it a potential active ingredient in solid soap formulations. Previous research has shown that red betel leaf extract has strong inhibitory power against Staphylococcus aureus bacteria at concentrations of 2.5%, 5%, and 7.5%, which is included in the strong category.

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The combination of betel leaf extract with avocado seed oil in a solid soap formulation is expected to provide better protection against bacterial infections on the skin.

Figure 3. Betel Leaf Extract

Saponification Process

The saponification process is the core of solid soap production and involves a complex chemical reaction between triglycerides and a strong base. The success of this process is greatly influenced by several factors, including the reaction temperature, the concentration of the NaOH solution, the type of oil used, and the reaction time.

Too low a temperature can slow the reaction rate, while too high a temperature can cause oil degradation and the formation of undesirable byproducts. The NaOH concentration must be calculated precisely based on the oil's saponification value to avoid excess free alkali, which can cause skin irritation.

The type of fatty acid in the oil also affects the properties of the resulting soap. For example, palmitic and stearic acids impart hardness to soap, while oleic and linoleic acids contribute to softness and lather. Therefore, soap formulations must be tailored to the characteristics of the oils used to produce optimal results.

The saponification process is the hydrolysis of triglycerides (oils or fats) with a strong base such as sodium hydroxide (NaOH) or potassium hydroxide (KOH), producing soap as the primary product and glycerol as a byproduct. The saponification reaction can be simply written as follows:

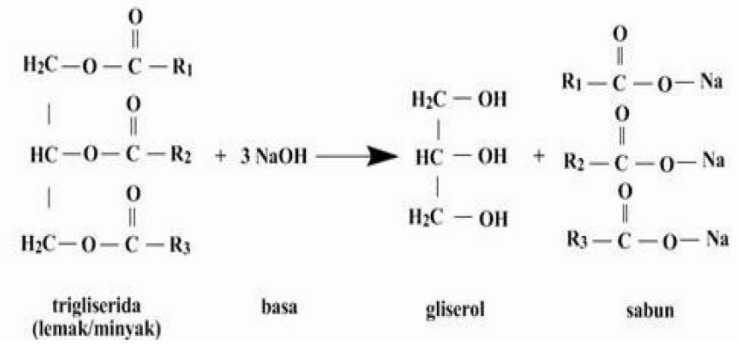

Figure 4. Saponification Process for Forming Solid Soap

In detail, triglycerides which are esters of glycerol and fatty acids react with a strong base (NaOH) to break the ester bonds, thus producing glycerol and sodium salts of fatty acids (soap).

Research Gap

Research on the manufacture of solid soap using vegetable oil as the base material and the addition of antibacterial plant extracts has been widely conducted, but the results and focus of the studies vary. To determine the position and novelty of this research, a search was conducted for several relevant national and international journals, particularly those discussing the use of avocado seed oil and betel leaf extract in soap product formulations and their antibacterial applications. A summary of the results

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of the literature review is presented in Table 2.1 below, which contains the reference sources, research title, research focus, and research gaps that form the basis for this research.

Table 1. Research Gap

Reference	Research Title	Research Focus	Research Gap
(Turangan et al., 2023b)	Making Transparent VCO Bath Soap with the Addition of Avocado Seed Extract as a Natural Antioxidant and Antibacterial.	Testing VCO + avocado seed based soap: soap quality & antibacterial activity	It does not use avocado seed oil as the main ingredient of solid soap (but rather VCO), and has not combined betel leaf extract, and has not explored two types of test bacteria.
(Sari et al., 2022)	The Effect of Ultrasonic Extraction Time of Green Betel Leaves (Piper betle L) on the Yield and Microbial Properties as Antiseptic Gel Additives.	Focus on betel leaf extract and antiseptic gel, not solid soap.	It has not been applied in avocado seed oil-based solid soap formulations, and has not evaluated the physical characteristics of the soap or its antibacterial activity comprehensively on two bacteria.
(Aji & Nuriani, 2018)	Utilization of Lemongrass Oil (Cymbopogon nardus L) as an Antioxidant in Solid Bath Soap.	Lemongrass oil, not avocado seed oil; different active ingredients	Neither avocado seed oil nor betel leaf extract was used. Therefore, the study has not addressed the gaps in the combination of these ingredients and the effect of varying ratios on soap characteristics and antibacterial activity against two types of bacteria.
(Hanum et al., 2012)	Extraction of Oil from Avocado Seeds Using N-Heptane Solvent.	Avocado seed oil extraction technique.	Does not discuss its use in solid soap.
(Nolalita et al., 2024)	*Effectiveness of Avocado Seed Extract on the Detergent Production Process.*	Utilization of avocado seed extract as a functional ingredient in the manufacture of detergents/cleaning products.	Demonstrates the bioactive potential of avocado seeds, but has not yet been combined with betel leaf extract in a solid soap formulation.
(Supraptiah et al., 2022)	*Utilization of Green Betel Leaves (Piper betle L.) Extract as an Additive Material on Paper Soap Production.*	Application of betel leaf extract in soap products (paper soap) and evaluation of basic properties.	Strengthening evidence that betel leaf extract can be applied to soap products. Gap: It has not been tested in avocado seed oil-based solid soaps and the ingredient ratio has not been compared.
(Dr. Hemalata Sagar Wadkar et al., 2025)	*Formulation and Evaluation of Antimicrobial Soap from Piper betle Extract.*	Antimicrobial soap formulation using betel leaf extract; antibacterial activity test.	Relevant for antibacterial methods but does not use avocado seed oil.

Based on the review of various studies listed in Table 1, it can be concluded that studies on the manufacture of solid soap using avocado seed oil and betel leaf extract are still very limited. Most previous studies have focused on the use of either ingredient alone, either a specific vegetable oil or betel leaf extract, and have not combined the two in a single solid soap formulation. Furthermore, existing studies generally only assess antibacterial activity against a single type of bacteria.

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Research methodology

Types and Design of Research

This research is a laboratory experimental study with a subjective approach that aims to determine the effect of varying concentrations of betel leaf extract on the physical characteristics and antibacterial activity of solid soap made from avocado seed oil. This study used a true experimental design with treatments in the form of varying concentrations of betel leaf extract added to the solid soap formulation.

The concentration variations of betel leaf extract and avocado seed oil used were 2:1 and 4:1. This study focused on:

1. Solid soap formulation with avocado seed oil as the main ingredient purchased in ready-to-use form.
2. The use of betel leaf extract is also obtained commercially, so the focus of the research is more on checking the physical characteristics and antibacterial effects of the combination of these ingredients in soap.

Preparation Stages

1. Tool Preparation

In the tool preparation stage, the tools that are prepared before being used to make soap are:

A. Analytical Balance
B. Beaker Glass
C. Beaker Glass
D. Stirring Rod
E. Spatula
F. *Hotplate*
G. Thermometer
H. Soap Mold
I. Digital / Paper pH Meter
J. Low Temperature Oven / Dryer
K. Antibacterial Test Equipment: Petri dish, Autoclave, Micropipette, Ose, Incubator
L. Inhibition Zone Measuring Tool (Millimeter ruler or caliper).

2. Preparation of Ingredients

In the material preparation stage, the materials that need to be prepared before making the ink are:

1. Avocado Seed Oil
2. Betel Leaf Extract
3. *Essential*Oil
4. Sodium Hydroxide (NaOH)
5. Sterile Aquadest
6. Test Bacteria: Staphylococcus Aureus and Escherichia Coli

Process Description

1. Preparation of NaOH Solution

The amount of NaOH solution used and required for each ratio varies. The required NaOH solution can be calculated using the following formula:

$$\text{massa KOH} = \frac{SV \times massa\ minyak}{1000}$$

$$\text{massa NaOH} = massaKOH \times 0.713$$

$$\text{NaOH akhir} = \text{massa NaOH} \times 0.95$$

NaOH solution was prepared by dissolving solid NaOH into sterile distilled water using a ratio of 1:3 (NaOH:water). In the formulation with a ratio of avocado seed oil: betel leaf extract of 2:1, 7.58 g of NaOH was used, dissolved in 22.7 mL of sterile distilled water.

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Meanwhile, in a 4:1 ratio, 9.10 g of NaOH was dissolved in 27.3 mL of sterile distilled water. Both NaOH solutions were then cooled to ±45°C before being slowly mixed into the oil that had been heated to the same temperature.

2. Solid Soap Formulation

A. Avocado seed oil was weighed at 66.66 g for a 2:1 ratio and 80 g for a 4:1 ratio.
B. The oil is heated at a temperature of 40-60oC on a hotplate.
C. The prepared NaOH solution is added slowly to the oil while stirring continuously until the saponification process occurs and the mixture begins to thicken (trace phase).
D. Once the mixture reaches the trace phase, add betel leaf extract according to the formula weight (33.33 g for a 2:1 ratio and 20 g for a 4:1 ratio). Stirring continues until homogeneous.
E. The soap mixture is poured into the mold and left for 24–48 hours to harden.
F. The hardened soap is stored in a cool, dry place for 2–4 weeks to mature and complete the saponification reaction.

3. Organoleptic Test of Solid Soap

A. pH test: Soap is dissolved in sterile distilled water (1 g soap in 10 mL distilled water), pH is measured with a digital pH meter or paper.
B. Pay attention to the scent, texture, and color of the soap.
C. Check the foam stability by measuring the initial foam height and the foam height after 5 minutes.

4. Antibacterial Activity Test

A. S. aureus and E. coli bacterial suspensions were prepared with a standard McFarland density of 0.5. The agar medium was inoculated evenly using sterile cotton.
B. The soap was cut into 0.25 g pieces, dissolved in 10 mL of sterile distilled water, heated in a water bath until dissolved, then cooled.
C. On the agar media inoculated with bacteria, wells with a diameter of 6 mm were made, then each well was filled with 100 µL of soap solution from each treatment.
D. The petri dishes were incubated at 37°C for 24 hours.
E. The diameter of the clear zone around the well was measured with a millimeter ruler as an indicator of antibacterial activity.

3 Flowchart

The following is a flow diagram of soap research using avocado seed oil and betel leaf extract as the basic ingredients.

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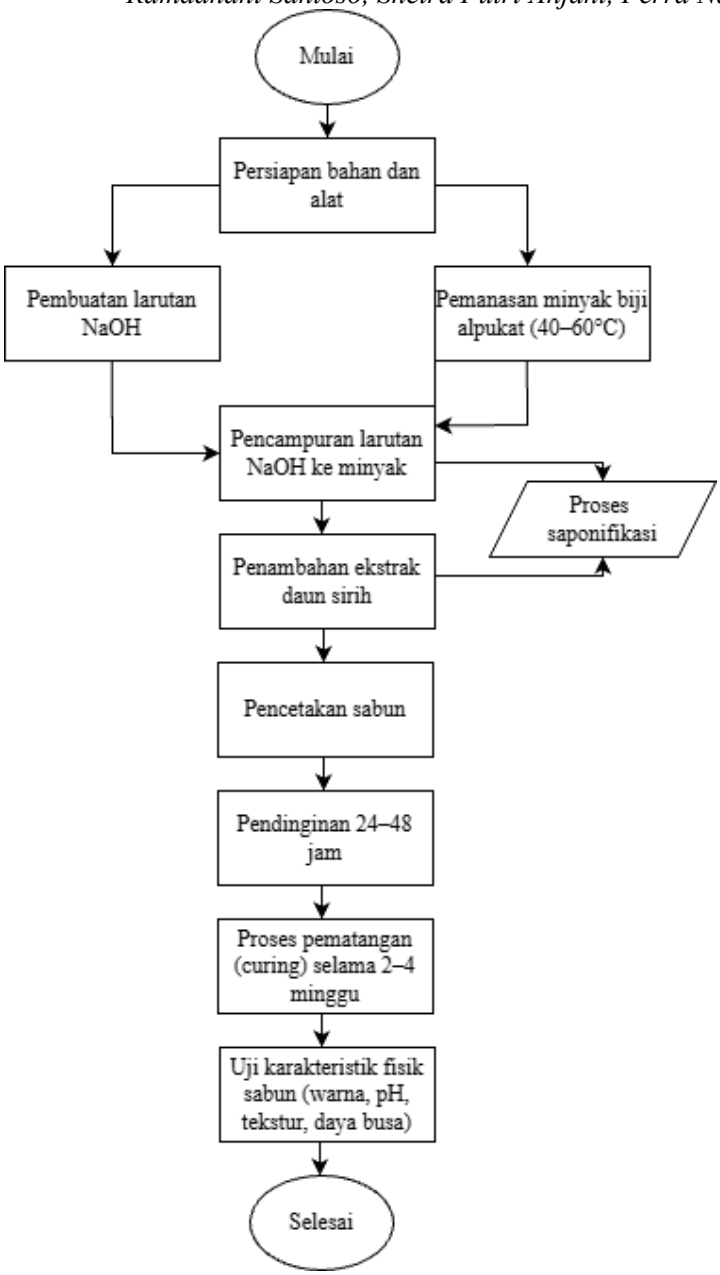

Figure 5. Research Flowchart

Data analysis

The organoleptic test results of the solid soap were carefully observed by researchers. The antibacterial activity test results of the solid soap were compared with commercial antiseptic soaps and with the solid soap quality standard (SNI 3532:2021) to ensure antibacterial activity.

This methodology covers all important aspects of material preparation, manufacturing process, physical characteristic testing, and antibacterial activity testing using valid and scientifically accountable methods.

Implementation Schedule

This research will be carried out at the Al Munawardin Chemistry Laboratory, Bhayangkara University, Jakarta Raya, within a period of approximately 6 months from the submission of the topic to the writing of the research paper, which can be seen in table 3.1.

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Research Budget

Based on the tools, materials, procedures, and requirements, a detailed research budget can be created. The research budget is shown in Table 2.

Table 2. Research Budget

No.	Activities and Components	Volume	Unit	Unit Price (Rp)	Amount (Rp)
	Preparation of Research Proposal				
1	Procurement Proposal	1	Package	20,000	Rp. 20,000
	Soap Making				
2	a. Avocado Seed Oil	3	Bottle	30,000	Rp90,000
	b. Betel Leaf Extract	2	Bottle	25,000	Rp. 50,000
	c. Essential Oil	1	Bottle	10,000	Rp. 10,000
	d. Silicone Soap Mold	1	Box	23,000	Rp. 23,000
	e. 150 sheets of tissue	1	Box	15,000	Rp. 15,000
	Soap Testing				
3	a. Digital pH Meter	1	Fruit	47,000	Rp. 47,000
	b. Test Bacteria	2	Fruit	115,000	Rp. 230,000
	Research Paper Submission				
4	Paper Submission Fee	1	Journal	500,000	Rp. 500,000
	Budget Amount (Rp)				Rp985,000

Results and Discussion

Research result

Based on the formula design, the main composition of each treatment is summarized in Table 3.

Table 3. Soap Formula Composition

Treatment (Oil : Extract)	Avocado seed oil (g)	Betel leaf extract (g)	NaOH (g)	Aquadest (mL)
02.01	66.66	33.33	7.58	22.7
04.01	80.00	20.00	9,10	27.3

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In general, both treatments produce a solid soap after the molding and curing process. The color and visual appearance of the soap are as follows:

1. Dominant color range: yellowish cream to light golden yellow.
2. Pattern/variation: there is light brown marbling/spots on some parts of the surface, and in certain parts it appears more translucent (slightly yellowish clear), a characteristic that often appears when there is a gel phase or local concentration of certain components (e.g. extracts/oxidation products).

Differences in surface appearance (rougher/granular and smoother/translucent) may be related to mixing homogeneity, dough temperature, cooling rate, and oil/extract fraction composition.

Organoleptic and pH Test Results

Characteristic testing was conducted using organoleptic parameters (aroma, texture, color) and other simple parameters (paper pH, pH after 5 minutes, initial and final foam height). A summary of the results is presented in Table 4.

Table 4. Results of Organoleptic Characterization of Solid Soap

Parameter	2:1 ratio soap	4:1 ratio soap
pH (paper)	10	10
pH (after 5 minutes)	10	10
Aroma	The smell of betel extract mixed with oil	The smell of betel extract is more pungent
Texture	Hard	Hard outside, softer inside
Color (observation results + photos)	Yellowish cream with light brown spots	Light golden yellow, partly translucent with light brown areas
Initial foam height	5.0 cm	5.5 cm
Final foam height (5 minutes)	3.5 cm	4.0 cm

To make the results more “valuable”, the foam data can be reduced to foam stability (%):

$$\text{Stabilitas busa} = \frac{\text{busa akhir}}{\text{busa awal}} \times 100\%$$

Table 5. Soap Foam Stability

Treatment	Initial foam (cm)	Final foam (cm)	Decrease (cm)	Stability (%)
02.01	5.0	3.5	1.5	70.0
04.01	5.5	4.0	1.5	72.7

Discussion

Avocado seed oil is a vegetable oil that is chemically dominated by triglycerides (glycerol esters with C16–C18 fatty acids). The fatty acid composition of avocado seed oil can vary depending on the raw material and extraction process, but one study of avocado seed oil extraction in Indonesia reported that the fatty acid fraction was dominated by unsaturated fatty acids, especially linoleic acid (PUFA) 47.35%, accompanied by palmitic acid (saturated) 20.34% and oleic acid (MUFA) 15.88%. (Risyad et al., 2016).

Implications on the properties of soap:

1. Saturated fatty acids (e.g. palmitic/stearic) tend to increase soap bar hardness and structural stability.
2. Unsaturated fatty acids (e.g. oleic/linoleic) tend to increase the conditioning sensation (softer) on the skin, but can make the soap softer and more susceptible to oxidation (rancidity) if not processed/stored properly.

International literature also indicates that oil from avocado parts (including seeds) remains a mixture of triglycerides with varying fatty acid profiles, and avocado oil quality studies emphasize the importance of quality control due to compositional variations and potential degradation/instability (Wang et al., 2020).

Soap is formed through a saponification reaction, a reaction between triglycerides (oils/fats) and the strong base NaOH, producing glycerol and sodium salts of fatty acids (hence "soap"). This concept

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is also emphasized in soap-making literature, stating that soap is the sodium/potassium salt of fatty acids resulting from saponification (Zuhra et al., 2023).

The measurement results show that the pH of the soap at both ratios is 10, both at the initial reading (pH paper) and after 5 minutes (pH remains 10), which indicates that when the soap comes into contact with water, the system quickly reaches a relatively constant state (dissolves/dispersed fairly homogeneously), so that there is no measurable change in pH over that time period.

Although a pH of 10 is common in bar soaps, human skin is normally more acidic. Double-blind studies monitoring skin pH have shown that the application of cold/hot process soaps can affect the acid-base balance of the skin's surface (skin acid mantle), so the pH aspect remains relevant in terms of comfort/irritation. (ZdradaNowak et al., 2025).

A pH of 10 also indicates that the soap is alkaline and has the potential to effectively remove oil/dirt, but for users with sensitive skin, it can cause a tight/drying feeling if it is not balanced with sufficient superfat or humectant.

The organoleptic results also showed that the soap ratio 2:1: the smell of betel extract mixed with the oil, while the soap ratio 4:1: the smell of betel extract was more pungent.

In theory, betel leaves contain active components (e.g., phenolic compounds and essential oil components) that contribute to their aroma and antibacterial activity. A national review indicates that green betel contains essential oils and active compounds, such as phenols/their derivatives, as well as other components that act as antibacterials (Sadiah et al., 2022).

An international review also confirmed the use of betel leaves in health and commercial applications due to their bioactive compounds and antimicrobial activity (Nayaka et al., 2021).

Descriptive explanation of soap aroma

1. If the heating is too high or too long, the volatile (light) components in the extract/essential oil evaporate more easily. As a result, the aroma profile shifts: the "fresh" components become less intense, leaving heavier components dominant, making the smell less pleasant or "heavier."
2. Avocado seed oil has a fairly large unsaturated fraction (linoleic/oleic) (Risyad et al., 2016), so it is susceptible to oxidation when exposed to heat + oxygen.

Studies of vegetable oil oxidation indicate that lipids are sensitive to environmental factors such as exposure to high temperatures and light, which promote the formation of free radicals and accelerate lipid oxidation. This oxidation degrades quality by triggering off-flavors (rancid/off-flavor) and changes in the oil's chemical properties (Gharby et al., 2025).

If avocado seed oil is heated too high before the NaOH is added, oxidation can occur first, resulting in the formation of oxidized compounds (e.g., carbonyl compounds) with an unpleasant odor. When subsequently saponified, this unpleasant odor doesn't automatically disappear and can even become "locked" in the soap matrix.

3. The addition of betel leaf extract to an alkaline system (NaOH/soap batter) can change the aroma profile because some components can undergo changes/reactions (for example phenolic oxidation) so that the final aroma is not always the same as the initial extract.

Conclusion

This study successfully synthesized solid soap from avocado seed oil with the addition of betel leaf extract using the saponification method. Both formulations, namely the ratio of avocado seed oil to betel leaf extract of 2:1 and 4:1, produced solid soap with good physical characteristics. The pH value of both formulations was at pH 10 so it was still in accordance with the general characteristics of sodium-based solid soap. The 4:1 ratio soap showed slightly higher foam stability of 72.7% compared to the 2:1 ratio of 70.0%, and produced a more homogeneous appearance with a light golden yellow color. Meanwhile, the 2:1 formulation provided a more balanced aroma between avocado seed oil and betel leaf extract. These results indicate that variations in the ratio of oil and extract affect the physical properties of soap, so that the composition of the ingredients is an important factor in determining product quality.

This study still has limitations because antibacterial activity testing has not been presented quantitatively through inhibition zone diameter data, so the antiseptic effectiveness of each formulation cannot be comprehensively compared. Furthermore, the number of formulation variations, tested quality parameters, and the research scale are still limited to simple laboratory testing. Future research is

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recommended to evaluate more composition variations, measure free fatty acid content, water content, free alkali, soap hardness, storage stability, and conduct statistical antibacterial tests on several types of bacteria according to SNI 3532:2021 standards. Practically, this study shows that the combination of avocado seed oil and betel leaf extract has the potential to be developed as an environmentally friendly natural antiseptic soap, utilizing avocado seed waste as a value-added raw material, and supporting the development of skin care products based on local resources.

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