

Original Article

## Production of Solid Soap from Arabica Coffee Grounds (*Coffea arabica* L.) with Antibacterial Properties

Ni Made Sukma Sanjiwani<sup>1\*</sup>, Komang Ariani<sup>1</sup>, I Made Agus Sunadi Putra<sup>1</sup>, I Wayan Surya Rahadi<sup>1</sup>, Ni Putu Ayu Mirah Mariati<sup>2</sup>, I Wayan Sudiarsa<sup>3</sup>, and Ni Nyoman Wahyu Udayani<sup>1</sup>

<sup>1</sup>Faculty of Pharmacy, Universitas Mahasaraswati Denpasar, Denpasar, Indonesia

<sup>2</sup>Faculty of Economic and Business, Universitas Mahasaraswati Denpasar, Denpasar, Indonesia

<sup>3</sup>Universitas PGRI Mahadewa Indonesia, Denpasar, Indonesia

\*Corresponding author: Ni Made Sukma Sanjiwani / Email: [sukmasanjwani@unmas.ac.id](mailto:sukmasanjwani@unmas.ac.id)

Received: 2 October 2025; Revised: 8 February 2026; Accepted: 13 February 2026; Published: 23 February 2026

**Abstract:** Coffee shops are now a favourite hangout for people of all ages, so many entrepreneurs are developing coffee shop businesses because of their high profit potential. Arabica coffee is the type of coffee most commonly used in coffee shops. The coffee-making process produces waste in the form of coffee grounds. Coffee grounds can be used as an ingredient in beauty products such as soap. Soap is the result of saponification, which is a reaction between a base or alkali and fatty acids, which acts as a skin cleanser. This study aims to examine the presence of secondary metabolite compounds in Arabica coffee grounds (*Coffea arabica* L.), test the physical quality of solid soap made from Arabica coffee grounds (*C. arabica* L.), and assess the soap's ability to inhibit the growth of *Staphylococcus aureus* bacteria. Arabica coffee grounds were first analysed through qualitative phytochemical screening tests using test tubes and various reagents, then formulated into solid soap with different concentrations, namely 4%, 7%, and 9%. After that, physical properties testing and antibacterial activity evaluation against *Staphylococcus aureus* were carried out using the disc diffusion method. The research results data were presented using descriptive analysis. The tests revealed that Arabica coffee residues contain secondary metabolites in the form of alkaloids, flavonoids, tannins, saponins, and triterpenoids. Solid soap made from Arabica coffee grounds meets the physical quality test standards in accordance with SNI 3532:2021 and that solid soap made from Arabica coffee grounds with a percentage of 7% (formula 2) and 9% (formula 3) has the potential to inhibit the activity of *Staphylococcus aureus* bacteria with a moderate category. It can be concluded that Arabica coffee grounds contain secondary metabolites such as alkaloids, flavonoids, tannins, saponins, and triterpenoids. Solid soap with Arabica coffee grounds as an ingredient meets the physical quality requirements in accordance with SNI 3532:2021. Soap formulas with a coffee grounds concentration of 7% (F2) and 9% (F3) have the potential to inhibit the growth of *Staphylococcus aureus* with moderate efficacy.

**Keywords:** physical quality, *Staphylococcus aureus*, triterpenoid

---

### 1. INTRODUCTION

Currently, the popular lifestyle of enjoying coffee is on the rise, making coffee drinking an integral part of everyone's daily routine. Coffee drinking can be done at home or outside, which we often refer to as 'hanging out', a term that is currently popular, where people gather and chat. One of the most frequently visited coffee drinking locations is the coffee shop. This place is now a favourite location for all ages, from young to old, because it has an Instagram-worthy atmosphere and maintains the quality of its coffee, so many entrepreneurs are venturing into the coffee shop business considering the promising profit prospects. The types of coffee commonly used are robusta and arabica, but most of the coffee used in coffee shops is arabica because of its distinctive taste and strong aroma [1].

The coffee brewing process in coffee shops utilises two methods, namely using an automatic coffee machine (espresso) and a manual method (brewing) [2]. The coffee-making process produces waste material in the form of coffee grounds. Coffee grounds contain antioxidants. These compounds have the ability to protect the skin from free radicals. In addition, coffee grounds also contain phenolic

compounds, caffeine, chlorogenic acid, polyphenols, and flavonoids [3], which can prevent premature skin ageing, remove dead skin cells, soften the skin, and reduce body odour [4]. Thus, coffee grounds can be used to make beauty products such as soap. Soap is the result of the saponification of fatty acids and alkali, which functions to cleanse the skin [5].

Previous research conducted by [6] processed coffee grounds into solid soap as an alternative to boost entrepreneurship in the MSME sector of the community in Kampung Wisata Kopi Lerek Gombengsari Banyuwangi. A study conducted by [7] on the use of orange peel extract and coffee grounds in the manufacture of foot spray reported that the third formula with a concentration of 0.15% was able to demonstrate antibacterial activity against *Staphylococcus aureus*, marked by the formation of an inhibition zone with a diameter of 6 mm. *S. aureus* bacteria are known to be one of the causes of body odour, especially when mixed with excessive sweat production in the armpits and other skin folds. *Staphylococcus aureus* is not dangerous, but it can infect broken skin or blocked sweat glands, so we need to use soap to cleanse the body to help reduce body odour and inhibit bacterial growth [8].

The problems addressed in this study are: What secondary metabolites are contained in Arabica coffee grounds (*Coffea arabica* L.), what is the physical quality of Arabica coffee grounds (*Coffea arabica* L.) solid soap preparations, and does Arabica coffee grounds (*Coffea arabica* L.) solid soap have the potential to inhibit the activity of *S. aureus* bacteria? The gap with previous studies is that no previous study has tested secondary metabolites in Arabica coffee grounds, and there has been no testing of the physical quality and antibacterial activity of solid soap made from Arabica coffee grounds. Previous studies have only limited themselves to making solid soap. The uniqueness of this study lies in the physical quality testing of the solid soap, which includes organoleptic testing, homogeneity, pH, foam height, and foam stability. The antibacterial activity testing uses the disc diffusion method and employs *S. aureus* bacteria.

Determination of plant species according to previous research [9] that the classification of Arabica coffee plants is kingdom: *Plantae*, Subkingdom: *Tracheobionta*, Division: *Magnoliophyta*, Class: *Magnoliopsida*, Subclass: *Asteridae*, Order: *Rubiales*, Family: *Rubiaceae*, Genus: *Coffea* and Species: *Coffea arabica* L.

Based on the background of solid soap production that has been applied in the form of MSMEs, there are still shortcomings in testing antibacterial activity. The author is interested in researching Arabica coffee grounds (*Coffea arabica* L.) by first conducting phytochemical screening tests, then using them as active ingredients in the process of making solid soap with formula development from research [10], followed by physical quality testing and antibacterial activity testing against *S. aureus*.

## 2. MATERIALS AND METHODS

### 2.1. Tools and Materials

In this research, various materials were used, including Arabica coffee grounds, coconut oil, olive oil, palm oil, sodium hydroxide (NaOH), distilled water, 2N HCl solution, Dragendorff's reagent, Mayer's reagent, amyl alcohol, magnesium powder (Mg), concentrated HCl, ferric chloride (FeCl<sub>3</sub>) solution, Lieberman-Burchard reagent, H<sub>2</sub>SO<sub>4</sub> solution, n-hexane, aluminium foil, parchment paper, Nutrient Agar, paper discs, and *Staphylococcus aureus* bacterial isolates obtained from the Kerthi Bali Sadhajiwa Health Laboratory Technical Implementation Unit, Bali Province. The equipment used in this study included test tubes (Pyrex, Iwaki®), dropper pipettes, stoves, pans, beakers (Herma®), measuring cups (Pyrex, Herma®), Erlenmeyer flasks (Pyrex®), filter paper, pH meters, stirring rods, porcelain dishes, soap moulds, digital scales, horn spoons, spatulas, autoclaves, hot plate magnetic stirrers, micropipettes, tweezers, Petri dishes, incubators, rulers, calipers, Bunsen burners, and Laminar Air Flow (LAF).

## 2.2 Methods

### 2.2.1. Collection of Arabica Coffee Grounds

The initial stage of this research involved collecting used Arabica coffee grounds from a coffee shop in the Ubud area of Gianyar, Bali.

### 2.2.2 Phytochemical Screening Test of Arabica Coffee Grounds

#### a. Alkaloids

Put half a gram of Arabica coffee grounds in a beaker, add 1 milliliter of 2N hydrochloric acid and 9 milliliters of distilled water, and stir to combine. The filtrate may be obtained by heating the mixture in a water bath for two minutes and then filtering it. The amount of Mayer's reagent given to each test tube was 1-2 ml, and 0.5 ml was taken from each filtrate. If a white precipitate was formed by the solution, it was considered a favorable outcome. The presence of alkaloids was confirmed by adding 1-2 ml of Dragendorff's reagent to an additional test tube, which resulted in the production of an orange or reddish-brown precipitate [11].

#### b. Flavonoids

The following steps were taken: weighing 0.5 g of Arabica coffee grounds, dissolving them in 10 ml of hot water, boiling for five minutes, and then filtering while still hot. The following ingredients were added to 1 milliliter of the obtained filtrate: 0.3 g of Mg powder, 1 ml of concentrated HCl, and 2 ml of amyl alcohol. Two distinct layers formed when the fluid was violently agitated. If the solution became red, yellow, or orange, it meant that the flavonoids were present [11].

#### c. Tannins

After heating for five minutes, 0.5 g of coffee grounds were dissolved in 10 ml of purified water. After filtering the solution, one milliliter was added to one or two milliliters of FeCl<sub>3</sub> solution. The presence of tannins was indicated by the production of a dark blue or blackish green color [11].

#### d. Saponin

After being chilled, 0.5 g of sample was combined with 10 ml of hot water. For 10 seconds, the filtrate was shook till foam started to develop. After that, 1 drop of 2N HCl was added to the solution. If the foam produced was stable and did not disappear quickly, the test result was categorised as positive for saponin [11].

#### e. Steroids or triterpenoids

A sample of Arabica coffee grounds weighing 0.5 g was weighed, then placed in an Erlenmeyer flask containing 10 ml of n-hexane. The container was covered with aluminium foil and shaken for 30 minutes. Next, it was filtered into an evaporating dish and left until the n-hexane solvent evaporated, leaving a residue. The residue was mixed with 2-3 drops of Liebermann Burchard reagent. A red/orange colour (triterpenoid) or blue-green colour (steroid) formed [11].

### 2.2.3 The process of making solid soap

The necessary tools and materials are prepared, then the ingredients are weighed according to the formula. Coconut oil, olive oil, and palm oil are placed in a container, then heated and stirred until evenly mixed (mixture I). NaOH is dissolved in water in a beaker and added to mixture I, stirred at a temperature of 38-43°C, then coffee grounds are added and stirred until slightly thickened to form a homogeneous 'light trace'. The formed 'light trace' is poured into a mould, wrapped in plastic and left at room temperature for one week so that the soap hardens completely (follow the same soap making method for formulas 0, 1, 2, and 3). The soap formulations are described in Table 1: (the reason for creating these soap formulations is to observe the differences resulting from the addition of Arabica coffee grounds).

**Table 1.** Arabica Coffee Grounds Solid Soap Formula

Name of Material	Formula				Function
	F0 (%)	F1 (%)	F2 (%)	F3 (%)	
Arabica coffee grounds	-	4	7	9	Active ingredient
Minyak kelapa	20	20	20	20	Natural foaming agent
Minyak Zaitun	21.2	20.8	20	20.2	Moisturiser
Palm Oil	20	20	20	20	Soap hardener
NaOH	8.8	8	7.5	7	Soap-forming agent or alkali
Aquadest	30	27.2	25.5	23.8	Solvent

Source: [10]

## 2.2.4 Physical Quality Test of Arabica Coffee Grounds Solid Soap

### a. Organoleptic test

Organoleptic observation of solid soap made from Arabica coffee grounds was carried out using human senses, including assessment of the product's shape, colour and aroma [12]. This procedure was repeated three times.

### b. Homogeneity test

To test for homogeneity, a small amount of soap preparation was placed on a transparent glass slide. The sample was observed to ensure that there were no coarse grains or visible particles [12]. This step was repeated three times.

### c. pH test

A pH meter was used to test the solution's pH after dissolving 1 gram of soap in 10 milliliters of distilled water [13]. This test was repeated three times.

### d. Foam height test

One gram of solid soap was mixed with ten milliliters of distilled water in a test tube and then shaken for one minute. The first measurement of the foam's height was taken using a ruler. After 5 minutes, it was measured again to acquire the final data for foam height [14]. The entire procedure was carried out three times.

### e. Foam stability test

Foam stability aims to determine the soap's ability to maintain the foam that is formed. This process is carried out by shaking the soap solution, then leaving it to stand for 5 minutes. The percentage of foam stability is calculated using the following established formula:

$$\% \text{ Foam Loss} = \frac{\text{Initial foam height} - \text{Final foam height}}{\text{Initial foam height}} \times 100\%$$

$$\text{Foam Stability} = 100\% - \% \text{ Foam Loss}$$

## 2.2.5 Antibacterial Activity Test of Arabica Coffee Grounds Solid Soap

### a. Sterilisation of equipment

All equipment to be used must first undergo sterilisation. Glass instruments are wrapped in parchment paper or aluminium foil, then placed in an autoclave at 121 °C for 15 minutes, after which they are removed and cooled. Meanwhile, for plastic equipment, the sterilisation process is carried out by spraying or soaking using 70% ethanol [15].

### b. Preparation of agar medium

Dissolve 4 g of Nutrient Agar (NA) powder in 200 mL of distilled water in an Erlenmeyer flask, then heat on a hot plate while stirring with a stirring rod until evenly mixed. After the solution has

been mixed well, the Erlenmeyer flask is sealed with aluminum foil and autoclaved at 121 °C for 15 minutes to ensure sterility [16].

c. Preparation of McFarland solution

In a test tube, combine 0.05 mL of a 1% BaCl<sub>2</sub> solution with 9.95 mL of a 1% H<sub>2</sub>SO<sub>4</sub> solution to get McFarland standard 0.5. To modify the density of the test bacterial suspension, the mixture is agitated until it becomes visibly hazy. This level of cloudiness serves as a reference [17].

d. Preparation of test bacterial suspension

After rejuvenation, one test bacterial culture is added to 10 mL of a physiological NaCl solution with a concentration of 0.9%. Then, it is adjusted such that the suspension's turbidity meets the McFarland 0.5 criterion [18].

e. Antibacterial activity test

To evaluate antimicrobial efficacy, researchers use the disc diffusion technique. The procedure involves pouring 1 mL of bacterial suspension into a Petri dish, then adding 15 mL of liquid Nutrient Agar. The medium is spread in a figure-eight pattern and left to solidify. Ten milliliters of water dissolves one gram of material [18]. A 6 mm diameter disc is soaked in 20 µL of sample solution for 15 minutes [13], then placed on the surface of the solidified agar. Incubation is carried out at 37 °C for 24 hours. The test media was divided into four groups: negative control (soap base without coffee grounds), formula 1 (soap + 4% coffee grounds), formula 2 (soap + 7% coffee grounds), and formula 3 (soap + 9% coffee grounds). After incubation, the inhibition zones formed were measured using a vernier caliper in millimetres (mm).

#### 2.2.6. Data Processing and Analysis

Data processing was carried out in a descriptive manner. The results of phytochemical screening of coffee grounds, organoleptic testing and homogenisation of Arabica coffee grounds soap were qualitative data, while the results of pH testing, foam height, foam stability, and antibacterial activity of coffee grounds soap are quantitative data, which were then tested using one-way ANOVA statistics for pH, foam stability, and antibacterial activity, while foam height was tested using two-way ANOVA.

### 3. RESULTS AND DISCUSSION

#### 3.1. Phytochemical Screening Test of Arabica Coffee Grounds

Phlorochemical screening studies have shown that secondary metabolites such as flavonoids, alkaloids, tannins, saponins, and triterpenoids have a favorable effect on Arabica coffee grounds (*Coffea arabica* L.). In Table 2 you can examine the specifics of the phytochemical data.

The purpose of phytochemical screening tests on Arabica coffee grounds (*Coffea arabica* L.) is to determine the presence of secondary metabolites still contained therein while providing a qualitative description of the groups of compounds found in the sample. The presence of alkaloid compounds in Arabica coffee grounds was determined by analyzing the data shown in Table 2. The presence of a white precipitate upon reaction with Mayer's reagent and a brownish-red precipitate with addition of Dragendorff's reagent provided conclusive confirmation of this. Arabica coffee grounds tested positive for flavonoids, showing two layers due to the addition of amyl alcohol and a colour change to reddish brown. The tannin test on Arabica coffee grounds showed positive results through a colour change to blackish green due to the addition of FeCl<sub>3</sub>.

**Table 2.** Results of Phytochemical Screening Tests on Arabica Coffee Grounds

Secondary Metabolite Compounds	Test Reagents	Observation on Arabica coffee grounds	Description
Alkaloids	Dragendorff	Formation of orange or reddish brown deposits	+
	Mayer	Formation of white deposits	+
Flavonoids	Mg powder + HCl pekat + amil alkohol	The presence of reddish-brown discoloration	+
	Tanins	FeCl 1%	The presence of blackish green or blackish blue discoloration (dark green)
Saponins	HCl 2N	Stable foam formation	+
Steroids atau Triterpenoids	Lieberman burchard	The presence of red (triterpenoid) or blue-green (steroid) colour changes	+(triterpenoids)

Arabica coffee grounds showed positive results for saponins, producing stable foam after the addition of 2N HCl. Arabica coffee grounds showed a positive reaction to triterpenoids due to a red colour change, caused by the ability of triterpenoid compounds to produce colour with H<sub>2</sub>SO<sub>4</sub> in the Lieberman Burchard reaction. These findings are in line with a previous study [19] that included phytochemical screening of coffee grounds, with the phytochemical screening process showing the positive presence of alkaloids, flavonoids, saponins, and triterpenoids. The alkaloid found in coffee grounds, namely caffeine, has antimicrobial and antioxidant characteristics that can protect the skin. Saponins act as natural cleansers and anti-inflammatory substances that can soothe the skin. Flavonoids protect the skin from free radicals, while triterpenoids are capable of regenerating skin cells [19]. This study is in line with phytochemical screening tests on Arabica coffee bean brews conducted by [20], with positive results for alkaloids, flavonoids, tannins, saponins, and triterpenoids.

### 3.2. Physical Quality Test of Arabica Coffee Grounds Solid Soap

#### 3.2.1. Organoleptic Test

Organoleptic testing of Arabica coffee grounds solid soap was conducted by directly observing the colour, aroma, and shape. The purpose of organoleptic testing of Arabica coffee grounds soap is to evaluate the physical appearance of the soap through human observation, such as the colour, aroma, and shape of the product [12]. Based on the observations the organoleptic test results for F0 show a yellowish-white colour, no aroma, and a solid shape. F1, F2, and F3 were dark brown in colour, had a coffee aroma, and were solid in shape. The blackish-brown colour of the soap was produced from Arabica coffee grounds without the addition of colouring because the active ingredients were already concentrated [21]. The soap had a coffee aroma because the grounds still retained the aroma of coffee, so the researchers did not use additional fragrance oils. However, the natural aroma of coffee does not last long. In all formulas, the soap has a solid form due to the saponification process and the hardness of the preparation is caused by the addition of coconut oil and palm oil. These ingredients harden the soap. If the soap does not solidify, it is unlikely to produce foam for cleaning the skin [18].

#### 3.2.2. Homogeneity Test

Testing of Arabica coffee grounds solid soap was carried out using a microscope slide, with each formula tested three times. The homogeneity of solid soap made from Arabica coffee grounds was assessed by taking a small sample and placing it on a glass slide/transparent glass to observe whether there were any coarse particles or grains [12]. The test results show that in the control formula (F0),

which was tested three times, the soap was declared homogeneous without any coarse grains because there was no addition of coffee grounds as an active ingredient, so the distribution of components was even. In contrast, formulas F1, F2, and F3 did not show uniformity due to the presence of coffee grounds particles. The coarse texture of coffee grounds caused the test results to not show good homogeneity. However, these particles can be utilised as an exfoliating agent to help remove dead skin cells on the skin surface.

3.2.3. pH test

pH measurements were carried out using a pH meter, with each formula being tested three times. The test results are shown in Table 3.

Table 3. pH Test Results for Solid Arabica Coffee Grounds Soap

Formula	pH			Average ± SD
	Replication 1	Replication 2	Replication 3	
0	10.09	10.09	10.03	10.07 ± 0.03
1	10.07	10.06	10.07	10.07 ± 0.01
2	10.04	10.00	10.01	10.02 ± 0.02
3	10.02	10.01	9.97	10.00 ± 0.01

pH describes the level of acidity or alkalinity of a material. The alkaline pH value of soap functions to open the pores of the skin, allowing the foam to bind excess oil (sebum) and dirt. However, soap with a pH that is too high or too low can increase skin penetration, potentially causing irritation. Based on Table 3, the average pH results of the solid soap tested three times showed a value of 10.07 for F0, 10.07 for F1, 10.02 for F2, and 10.00 for F3. All four formulas still comply with the SNI 3532:2021 solid soap pH quality standard, which is 6–11 [22]. These findings show that adding coffee grounds can lower the pH of soap [23].

ANOVA

pH	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	256034.390	3	85344.797	1.022	.433
Within Groups	668111.431	8	83513.929		
Total	924145.821	11			

There is no statistically significant change, according to the ANOVA findings ( $p=0.433>0.05$ ). After running the one-way ANOVA, we found a Sig. of 0.433, which is higher than the 0.05 threshold of significance ( $p>0.05$ ). This means that the pH value was unaffected by the formula treatment. Therefore, we adopt the null hypothesis ( $H_0$ ), which claims that the average pH of formulae 0, 1, 2, and 3 is not significantly different. The variation in pH values observed in each formula is still within the natural range of variation (error) and is not large enough to be considered statistically significant. The pH values for all formulas were within a relatively narrow range, between 10.00 and 10.07, with a low standard deviation. This indicates that changes in the formula composition did not have a significant impact on the pH characteristics of the product. In addition, the relatively small calculated F value ( $F = 1.022$ ) shows that the variation between groups was smaller than the variation within groups.

3.2.4. Foam Height Test

Foam height measurements were taken three times for each formula, with the results presented in Table 4.

**Table 4.** Results of Foam Height Test for Solid Soap Made from Arabica Coffee Grounds

Formula	Replication	Foam Height	
		First minute foam height (cm)	Foam height after 5 minutes (cm)
0	1	8.5	7.6
	2	8.3	7.5
	3	9	7.7
	Average ± SD	8.6 ± 0.36	7.6 ± 0.10
1	1	8	7.1
	2	8.3	7.3
	3	8	7
	Average ± SD	8.1 ± 0.17	7.1 ± 0.15
2	1	8.5	7.6
	2	8.1	6.7
	3	8.2	7.1
	Average ± SD	8.3 ± 0.21	7.1 ± 0.45
3	1	8.2	7.1
	2	8.1	7.1
	3	8.8	7.7
	Average ± SD	8.4 ± 0.38	7.3 ± 0.35

**Tests of Between-Subjects Effects**

Dependent Variable: result

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	6.357 <sup>a</sup>	7	.908	8.250	.000
Intercept	1453.615	1	1453.615	13205.181	.000
Formulaa	.455	3	.152	1.379	.285
Tinggibusa	5.782	1	5.782	52.526	.000
Formulaa * Tinggibusa	.119	3	.040	.362	.782
Error	1.761	16	.110		
Total	1461.733	24			
Corrected Total	8.118	23			

a. R Squared = .783 (Adjusted R Squared = .688)

A two-way analysis of variance (ANOVA) was conducted to determine the effect of formula, foam height, and the interaction between formula and foam height on the results (dependent variable). The analysis results showed that the corrected model was statistically significant (F = 8.250; p = 0.000). This indicates that the combination of factors analysed simultaneously had a significant effect on the outcome variable. An R<sup>2</sup> value of 0.783 indicates that 78.3% of the variation in the outcome data can be explained by the model, while the remainder is influenced by other factors outside the model.

**Influence of Main Factors:**

**a. Influence of Formula**

The formula factor did not show a significant influence on the outcome variable (F = 1.379; p = 0.285; p > 0.05). This indicates that differences in the formulas used did not cause statistically significant differences in the results.

**b. Effect of Foam Height**

The foam height factor shows a very significant effect on the outcome variable (F = 52.526; p = 0.000; p < 0.05). This indicates that differences in foam height significantly affect the outcome and are a major factor contributing to data variation.

The analysis results indicate that the interaction between formula and foam height (Formula × Foam Height) does not have a significant effect on the outcome variable ( $F = 0.362$ ;  $p = 0.782$ ;  $p > 0.05$ ). This indicates that the effect of foam height on the outcome is consistent across all formulas, so that the effects of the two factors are independent. Based on the results of the two-way ANOVA, it can be concluded that: Foam height has a significant effect on the outcome, Formula has no significant effect on the outcome, and There is no significant interaction between formula and foam height. Thus, variation in the outcome is determined more by the foam height factor than by differences in the formula used.

### 3.2.5. Foam Stability Test

Foam stability testing can be seen in Table 5.

**Table 5.** Results of Stability Tests on Solid Soap Foam Made from Arabica Coffee Grounds

Formula	Replication	Foam Stability (%)
0	1	89.4
	2	90.4
	3	85.6
	Average ± SD	88.4 ± 2.55
1	1	88.75
	2	88.0
	3	87.5
	Average ± SD	88.1 ± 0.63
2	1	89.4
	2	82.7
	3	86.6
	Average ± SD	86.2 ± 3.36
3	1	86.6
	2	87.7
	3	87.5
	Average ± SD	87.2 ± 0.58

Soap foam was observed at the first minute and after five minutes. The replication results showed that the average foam height of formula F0 was 8.6 cm in the first minute and 7.6 cm after five minutes, while F1, F2, and F3 had average values of 8.1 cm, 8.3 cm, and 8.4 cm at the start of observation, and 7.1 cm, 7.1 cm, and 7.3 cm after five minutes, respectively. Foam stability was evaluated to determine the soap’s ability to maintain the foam formed. The measurement results are listed in Table 7. The average foam stability values were 88.4% (F0), 88.1% (F1), 86.2% (F2), and 87.2% (F3), respectively. Testing foam height and stability is important in assessing solid soap formulations. Abundant foam is indeed one indicator of soap quality, but excessive amounts can cause the skin to dry out more quickly. Tables 4 and 5 show that all formulas meet SNI standards, namely foam height of 1.3–22 cm and foam stability of 60–90% [21]. Higher coffee grounds concentrations in F1–F3 tended to reduce foam height. Factors affecting foam stability include active ingredients, surfactants, foam stabilisers, and other soap components [21].

#### ANOVA

foam stability	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	8.799	3	2.933	.635	.613
Within Groups	36.952	8	4.619		
Total	45.751	11			

Sig. = 0.613, which is higher than the 0.05 significance threshold, was found to be the outcome of a one-way ANOVA on foam stability characteristics ( $p > 0.05$ ). According to these findings, foam

stability was unaffected by the formula treatment. Therefore, we accept the null hypothesis ( $H_0$ ), which claims that the investigated formulae do not significantly vary in their average foam stability. The calculated F value of 0.635 indicates that the variation between treatment groups is smaller than the variation within groups, so that the differences that arise are still within the natural variation of the data. In addition, the sum of squares within groups (Within Groups) is greater than that between groups (Between Groups), indicating that the variation in foam stability data is more influenced by internal measurement variation than by differences in formula treatment.

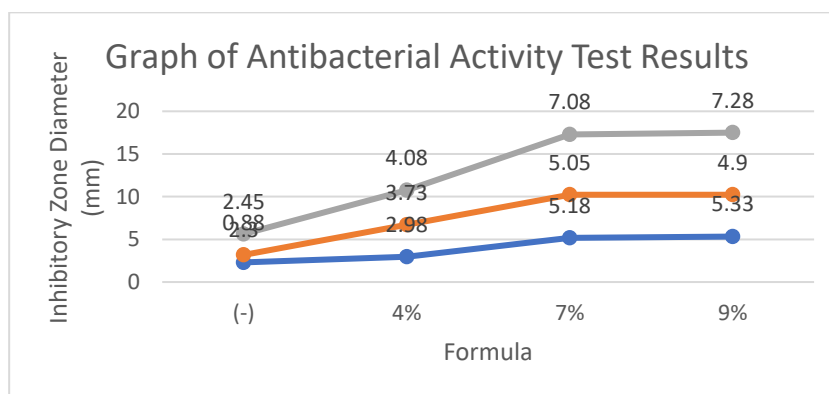
### 3.3. Antibacterial Activity Test of Arabica Coffee Grounds Solid Soap

Disc diffusion was used to ascertain the soap's antibacterial properties, which was made from solid Arabica coffee grounds. As part of the experiment, a disc of paper was dipped into the soap solution and then set on top of agar. The antibacterial activity was evidenced by the existence of a clear zone around the disc. You may see the full set of findings in Table 6.

Table 6. Antibacterial Activity Test Results

Treatment	Concentration	Diameter of the Inhibition Zone (mm)			Average $\pm$ SD	Categories
		I	II	III		
Control	(-)	2.3	0.88	2.45	1.88 $\pm$ 0.87	Weak
Formula (arabica coffee grounds solid soap)	4%	2.98	3.73	4.08	3.59 $\pm$ 0.56	Weak
	7%	5.18	5.05	7.08	5.77 $\pm$ 1.13	Moderate
	9%	5.33	4.9	7.28	5.83 $\pm$ 1.27	Moderate

Description: Control (-) = soap without coffee grounds



Description: blue = replication 1; orange = replication 2; grey = replication 3

Figure 1. Graph of Antibacterial Activity Test Results

Antibacterial test results show that solid soap made from Arabica coffee grounds is capable of producing a clear zone around the paper disc on a medium inoculated with *Staphylococcus aureus* bacteria. Based on Table 6 and Figure 1, formula F1 with a concentration of 4% shows an average inhibition zone diameter of 3.59 mm, which is classified as weak. Formula F2 with a concentration of 7% produced a diameter of 5.77 mm and was categorised as moderate, while F3 at a concentration of 9% showed an inhibition zone of 5.83 mm, which was also classified as moderate. Meanwhile, the negative control only produced a diameter of 1.88 mm, which was categorised as weak, originating from soap without the addition of active substances. The use of a negative control is not only for comparison but also serves to ensure that additives or solvents do not affect the antibacterial activity test results [24]. In Figure 1, there are no error bars for the precision of the results.

The clear zone formed on the negative control is thought to originate from saponins produced by the saponification process. This chemical kills bacteria by lowering their surface tension, which in turn releases intracellular components and causes cell death [25]. The addition of an active substance in the form of Arabica coffee grounds strengthens the inhibitory effect on bacterial growth, as shown

in Table 6. The inhibitory zone's width increases with increasing concentration. Bioactive compounds such as caffeine, polyphenols, flavonoids, and chlorogenic acid [26] in coffee grounds still play an important role as antibacterial, anti-inflammatory, and anti-aging agents for skin care [27]. This fact is also supported by phytochemical screening results showing the presence of alkaloids, flavonoids, tannins, saponins, and triterpenoids.

Following in the footsteps of earlier studies done by [28], which processed Arabica coffee husk waste into solid soap. The soap inhibited *Staphylococcus aureus* with an average inhibition zone width of 7.45 mm after adding 3% active coffee husk extract. Another study conducted by [20] showed that a 7.2% arabica coffee infusion against *Escherichia coli* produced an inhibition zone of 5.3 mm, which is classified as moderate. Polyphenolic compounds, particularly chlorogenic acid, are known to prevent bacterial adhesion and inhibit biofilm formation, while alkaloids play a role in disrupting peptidoglycan in the bacterial cell wall so that the cells do not form properly and eventually die.

ANOVA

result

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	32.658	3	10.886	10.978	.003
Within Groups	7.933	8	.992		
Total	40.590	11			

An analysis of variance (ANOVA) on the inhibition zone diameter yielded a significance value (Sig.) of 0.003, which is less than the significance threshold of 0.05 ( $p < 0.05$ ). Based on these findings, a notable variation in concentration exists. Based on the ANOVA results, further analysis (post hoc test) needs to be conducted to determine which concentration pairs show significant differences.

Multiple Comparisons; Dependent Variable: result; Tukey HSD

(I) concentration	(J) concentration	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
0	1	-1.72000	.81306	.227	-4.3237	.8837
	2	-3.89333*	.81306	.006	-6.4970	-1.2896
	3	-3.96000*	.81306	.005	-6.5637	-1.3563
1	0	1.72000	.81306	.227	-.8837	4.3237
	2	-2.17333	.81306	.106	-4.7770	.4304
	3	-2.24000	.81306	.094	-4.8437	.3637
2	0	3.89333*	.81306	.006	1.2896	6.4970
	1	2.17333	.81306	.106	-.4304	4.7770
	3	-.06667	.81306	1.000	-2.6704	2.5370
3	0	3.96000*	.81306	.005	1.3563	6.5637
	1	2.24000	.81306	.094	-.3637	4.8437
	2	.06667	.81306	1.000	-2.5370	2.6704

\*. The mean difference is significant at the 0.05 level.

There is a difference between no concentration (-) and a concentration of 7%.

There is a difference between no concentration (-) and a concentration of 9%.

Result; Tukey HSDa

Concentration	N	Subset for alpha = 0.05	
		1	2
0	3	1.8767	
1	3	3.5967	3.5967
2	3		5.7700
3	3		5.8367
Sig.		.227	.094

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

## 5. CONCLUSION

The study's findings suggest that Arabica coffee grounds have secondary metabolites including triterpenoids, alkaloids, tannins, and flavonoids. Solid soap made from Arabica coffee grounds meets the physical quality requirements of SNI 3532:2021. Soap formulas with coffee grounds concentrations of 7% (F2) and 9% (F3) have the potential to inhibit the growth of *Staphylococcus aureus* with moderate effectiveness.

### Funding: -

**Acknowledgements:** The author would like to express his appreciation to the Faculty of Pharmacy, Mahasaraswati University Denpasar, for the support and facilities provided during the conduct of this research

**Conflict of Interest:** There is no conflict of interest

## References

- [1] Desty RT, Waris MA, Putri RR. Knowledge, Attitudes and Behaviours of Students Towards the Wound Healing Effects of Coffee Powder (*Coffea* sp.). *Borneo Journal of Pharmascientech*. 9(2):183-90. 2025.
- [2] Ardiyasa, G., Barustyawat, A. A. S., & Paramarta, I. M. S. Customers' Interest in the Coffee Products Brewing Methods at Temani Coffee Shop. 1(July), 27–30. 2024.
- [3] Khoiroh, I. U. Characteristics and Hedonic Testing of Soap Made from Coffee Grounds Waste. *Journal of Biology and Its Applications*, 15(1), 37–48. 2024.
- [4] Pratiwi, M. A., Sutanti, S., Rahayu, L. H., & Khasanah, I. N. Production of Solid Coffee Aromatherapy Soap Based on Virgin Coconut Oil and Stearic Acid Using the Heat Method. *Journal of Chemical Engineering Innovation*, 8(1), 1–5. 2023.
- [5] Aris, A., Naningsih, N., & Ratnah. Saponification Test of Triacylglycerol in Organic Soap Using Environmentally Friendly Oil in Post-Covid-19 Pandemic Innovation Efforts. *Jurnal Abdi*, 3(1), 12–13. 2021.
- [6] Purwaningtyas, A., Yustita, A. D., & Utami, S. W. Utilisation of coffee grounds waste in the production of bar soap in the Lerek Gombengsari Banyuwangi Coffee Tourism Village. *Dinamisia: Journal of Community Service*, 6(4), 1050–1055. 2022.
- [7] Ashfia, F., Adriane, F. Y., Sari, D. P., & Rusmini. Anti-Foot Odour Spray Containing Lime Peel Extract and Coffee Grounds. *Indonesian Chemistry and Application Journal*, 1, 28–33. 2019.
- [8] Hasan, T. A., Tobi, C. H. B., & Pratiwi, M. E. Formulation of Transparent Herbal Soap from Purified Extracts of Beluntas Leaves (*Pluchea indica* L.) to Combat Body Odour-Causing Bacteria. *Mandala Pharmacon Indonesia Journal*, 10(2), 628-636. 2024.
- [9] Muharam F. Potential of Arabica Coffee (*Coffea arabica* L.) from Various Pharmacological Activities & Pharmaceutical Preparation Forms: Review: Potential Arabica Coffee (*Coffea arabica* L.) from Various Pharmacological Activities & Pharmaceutical Preparation Forms. *Medical Sciences: Scientific Journal of Pharmacy*. 7(3):395-406. 2022.
- [10] Misgiati. Physical Quality of Solid Soap from Coffee Bean Extract (*Coffea robusta*). *Journal of Pharmacy and Nutrition*, 4(1), 37–44. 2024.
- [11] Maharani, S., Meilina, R., Dina, P., Kulla, K., & Rezeki, S. Phytochemical Screening of Secondary Metabolite Compounds and Standardisation of Licorice Root (*Glycyrrhiza glabra* L.). 10(1), 506–518. 2024.
- [12] Yusriyani, Syarifuddin K.A, S. Formulation and Physical Quality Testing of Liquid Soap Preparations from Plantain Fruit Peel Extract (*Musa balbisiana*). *Yamasi Makassar Health Journal*, 6(2), 89–98. 2022.
- [13] Nur Inayah, Ery Nourika Alfiraza, & Desi Sri Rejeki. Testing the Activity of Solid Soap Preparations Combining Basil Leaf Extract (*Ocimum sanctum* L.) and Bandotan Leaf Extract (*Ageratum Conyzoides* Sleberex Steud) against Propionibacterium Acnes Bacteria. *Jurnal Medika Nusantara*, 2(3), 210–220. 2024.
- [14] Fanani, Z., Panagan, A. T., & Apriyani, N. Quality Test of Transparent Solid Soap from Coconut Oil and Palm Oil with Tomato Fruit Lycopene Extract Antioxidants. *Journal of Scientific Research*, 22(3), 108-118. 2020.
- [15] Putra, T. A., Ulfah, M., & Syarifah, N. A. Antibacterial Activity Test of Solid Soap Preparation from Bali Orange (*Citrus maxima*) Ethanol Extract against *Staphylococcus aureus* and *Pseudomonas aeruginosa* Bacteria. *Journal of Medical Pharmacy*, 7(1), 1–9. 2024.
- [16] Noviyanty, Y., Bengkulu, F. A., Kesehatan, A., & Bangsa, H. Comparison of the Antibacterial Activity of Transparent Solid Soap with Lemongrass Essential Oil (*Cymbopogon citrates* (DC.) Stapf) against *Staphylococcus aureus* and *Escherichia coli* Bacteria. *Oceana Biomedicina Journal*, 4(1), 38–52. 2021.

- [17] Damayanti, H., Zaky, M., & Maulana, M. F. N. I. Formulation of Solid Soap from 96% Ethanol Extract of Soursoop Leaves (*Annona muricata* L.) as an Antibacterial Agent (*Staphylococcus aureus*). *Farmagazine*, IX(2), 47–56. 2022.
- [18] Mopangga, E., Yamlean, P. V. Y., & Abdullah, S. S. Formulation of Solid Bath Soap from Ethanol Extract of Gedi Leaves (*Abelmoschus manihot* L.) against *Staphylococcus epidermidis* Bacteria. *Jurnal Pharmacon*, 10(3), 1017–1024. 2021.
- [19] Asyraf, I., & Hayati, R. Utilisation of a Combination of Arabica Coffee Grounds and Tea Leaves: Potential as a Natural Body Scrub. *JAFP (Prayoga Pharmacy Academy Journal)*, 9(2), 1-12. 2024.
- [20] Wulan, M., Rubiyanti, R., & Sutiswa, S. I. Testing the Activity of Arabica Coffee Bean (*Coffea arabica* L.) Infusion against *Escherichia coli* Bacteria that Cause Diarrhoea. In *Proceedings of the National Seminar on Research Dissemination Volume 3*, 3(1), 237-243. 2023.
- [21] Fanani, Z., Vivin Rosvita, Nur Aisah, Novam Danu Pamungkas, & Ilun Fadillah. Formulation of Solid Bath Soap with Active Ingredients from Avocado Fruit Peel Extract (*Persea americana* MILL). *CERATA Journal of Pharmaceutical Sciences*, 12(2), 21–26. 2021.
- [22] Rizkina, S. N., Noer, S., & A, Z. F. Proceedings of the National Seminar on the Antibacterial Activity of Harendong Bulu Leaf Extract (*Clidemia hirta*) in Transparent Solid Soap Preparations Against *Propionibacterium acnes*. *Proceedings of the 2024 National Science Seminar*, 5(1), 131–139. 2024.
- [23] Lau, E. Y., Mangiwa, S., & Maryuni, A. E. Formulation and Quality Testing of Solid Soap with the Addition of Ethanol Extract of Arabica Coffee Beans (*Coffea arabica* L) from Wamena, Jayawijaya Regency. *Journal of Chemistry*, 5(November), 1–23. 2021.
- [24] Ardiansah, N., Ifaya, M., & Fauziah, R. Antimicrobial Activity Test of *Meistera chinensis* Leaf Ethanol Extract Against *Escherichia coli* Bacteria and *Candida albicans* Fungi. *Jurnal Pharmacia Mandala Waluya*, 4(2), 142–155. 2025.
- [25] Purba, R., Saleh, C., Kimia, S., Mulawarman, U., Organik, L. K., Kimia, P. S., & Mulawarman, U. Phytochemical Screening and Antibacterial Potential of Ethanol Extracts of Forest Betel Leaf (*Piper aduncum* L.) against *Escherichia coli* and *Staphylococcus aureus* Bacteria. *Proceedings of the 2024 National Chemistry Seminar*, 78–82. 2024.
- [26] Ginting, B., Oktavianty, H., & Ngatirah. Formulation of Body Scrub from Coffee Grounds. *Agroforetech*, 1(1), 562–571. 2023.
- [27] Insaniah, N., Darwis, Z., Izzah, N., Khalid, I., Dariyanti, E. W., & Makassar, M. A. N. Flavonoid Content in Toraja Coffee Grounds for Reducing Acne in Adolescents. September, 1210–1221. 2024.
- [28] Andini, S. P., Theresia, R., & Supriyono, L. A. Development and Characterisation of Innovative Bar Soap Formulations Using Gayo Arabica Coffee Husk Extract: Focusing on Physical Properties and Antibacterial Activity Using a pH Meter Sensor. *Journal of Health Science and Technology*, 16(1). 69–73. 2025.

