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Physicochemical Characteristics and Anti-Bacterial Ability of Liquid Soap with the Addition of Pandan Wangi Extract

Karakteristik Fisikokimia Dan Kemampuan Anti Bakteri Sabun Cair dengan Penambahan Ekstrak Pandan wangi

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Abstract

Pandan wangi leaves have bioactive properties that can inhibit the growth of *Staphylococcus aureus* and *Escherichia coli* bacteria so they can prevent skin infections. The ability of *pandan wangi* leaf extract to inhibit microbial growth can be applied to liquid soap. This research was conducted to determine the characteristics of liquid soap with the addition of *pandan wangi* leaf extract. This study used a completely randomized design with five treatments and three replications. The treatment in this study was a variation of adding *pandan wangi* leaf extract to the liquid. soap formulation, which were 1.5; 2.0; 2.5; 3.0; and 3.5 grams. The data obtained was analyzed statistically using analysis of variance (ANOVA). The results of variance showed that the addition of *pandan wangi* leaf extract had a significant effect on foam stability, acidity (pH), anti-bacterial activity test, and sensory test. The liquid soap treatment chosen in this study was the addition of 3.5 grams of *pandan wangi* extract with a foam stability value of 81.52%, specific gravity of 1.0596 g/ml, viscosity of 271.7 mPas, acidity of 9.02, amount of free alkali 0%, has an anti-bacterial inhibition zone against *Escherichia coli* 11.22 mm and *Escherichia coli* 12.22 mm, does not irritate, and is preferred by hedonic panelists with a description of *pandan wangi* aroma.
Keywords: anti-bacterial, liquid bath soap, *pandan wangi* leaf extract

Abstrak

Daun pandan memiliki sifat bioaktif yang dapat menghambat pertumbuhan bakteri Staphylococcus aureus dan Escherichia coli sehingga dapat mencegah infeksi kulit. Kemampuan ekstrak daun pandan wangi dalam menghambat pertumbuhan mikroba dapat diaplikasikan pada sabun cair. Penelitian ini dilakukan untuk mengetahui karakteristis sabun cair dengan penambahan ekstrak daun pandan wangi. Penelitian ini menggunakan rancangan acak lengkap dengan lima perlakuan dan tiga ulangan. Perlakuan dalam penelitian ini adalah variasi penambahan ekstrak daun pandan wangi dalam cairan. formulasi sabun, yaitu 1,5; 2,0; 2,5; 3,0; dan 3,5 gram. Data yang diperoleh dianalisis secara statistik menggunakan analysis of variance (ANOVA). Hasil varians menunjukkan bahwa penambahan ekstrak daun pandan wangi berpengaruh nyata terhadap stabilitas busa, keasaman (pH), uji aktivitas antibakteri, dan uji sensorik. Perlakuan sabun cair yang dipilih dalam penelitian ini adalah perlakuan penambahan 3,5 gram ekstrak pandan wangi dengan nilai stabilitas busa 81,52%, berat jenis 1,0596 g/ml, viskositas 271,7 mPas, keasaman 9,02, jumlah alkali bebas 0%, memiliki anti- zona hambat bakteri terhadap Escherichia coli 11,22 mm dan Escherichia coli 12,22 mm, tidak mengiritasi, dan disukai panelis hedonis dengan deskripsi aroma pandan wangi.
Kata kunci*: anti bakteri, ekstrak daun pandan wangi, sabun mandi cair*

INTRODUCTION

Skin is one of the most important parts of the human body that protects the body inside from physical, mechanical, heat, cold, radiation disturbances, ultraviolet, germs, bacteria, fungi, and viruses. The skin also functions to excrete sweating or metabolic waste, sense (tasting), and control body temperature (Wang et al., 2019). The skin function is very important, so the skin must always be kept clean. Damage to the skin, such as irritation, will eliminate the skin function as a barrier against microbial infection.

Microbial skin infections can be prevented by using cosmetic skin products, including soap (Zubair et al., 2018).

Soap is a cosmetic that can be used as a non-natural skin protectant and treat skin diseases caused by bacteria and fungi. Good quality soap must have sufficiently high detergency, be applicable to various types of materials, and remain effective even when used at different temperatures and water hardness (Kurniawan & Zafira, 2022).

Soap can be solid or liquid. Liquid soap is produced for various purposes, such as bathing, washing hands, washing dishes, or other needs (SNI 06-4085-1996. Sabun Mandi Cair, 1996). Liquid soap is made by oil and fat saponification reaction with KOH (Predianto et al., 2017). Liquid soap is preferred over solid soap because it is more practice to be used, dissolves easily in water because it contains KOH, foams easily, sterilization maintained, and is easy to carry (Rusdianto et al., 2021). Liquid bath soap is a liquid substance used to clean the skin and does not cause skin irritation, made from soap-based ingredients with or without thickeners, foam stabilizers, and fragrances. Anti-bacterial liquid soap can clean the skin from dirt and remove bacteria.

Many anti-bacterial liquid soaps sold in the market contain synthetic ingredients, such as Sodium Lauryl Sulfate (SLS) and triclocarban. Anti-bacterial synthetic materials can prevent infection, but some synthetic materials have side effects such as irritation. A way to avoid side effects caused by synthetic materials is to use natural ingredients as anti-bacterial, including *pandan wangi* leaves (Bali et al., 2019).

Generally, *pandan wangi* leaves are used as a cooking spice, flavoring, and coloring. *Pandan wangi* leaves contain chemical compounds, including alkaloids, saponins, flavonoids, terpenoids, tannins, polyphenols, and dyes (Apriliani et al., 2018). The fragrant component of *pandan wangi* leaves comes from the chemical compound 2-acetyl-1-pyrroline. *Pandan wangi* leaves contain anti-bacterial, which is good for the skin and contains antioxidants that can prevent rancidity in soap. Using natural anti-bacterial substances does not cause side effects, does not require high costs, and is easy to find in the environment (Ahmed et al., 2022).

Using plants containing natural anti-bacterial chemicals is expected to suppress the growth of *Staphylococcus aureus* and *Escherichia coli*. These two bacteria are the most common bacteria that attack humans (Nabilla & Advinda, 2022). Ismiyati et al. (2021) researched the potential of *pandan wangi* leaf extract as an anti-bacterial using a mixture of ethanol-ethyl acetate (1:1 v/v). The research showed that the bacterial growth inhibition zone was 15.67 mm for *Staphylococcus aureus* and 17.67 mm for *Escherichia coli*. Research by Dasopang & Simutuah (2016) on antiseptic gels showed that the ethanol extract of *pandan wangi* leaves had anti-bacterial activity at a concentration of 10%. The inhibition zone for *Staphylococcus aureus* was 13.23 mm and 13.13 mm for *Escherichia coli*. Research results by Apriliani et al. (2018) regarding the transparent soap manufacture showed that *pandan wangi* leaf extract at a concentration of 4% gave an irritation test value of 0 (no irritation occurred), foam stability of 85.39% and an acidity degree of 10.03. Anti-bacterial activity testing using *Staphylococcus aureus* and *Escherichia coli* on liquid soap has never been done before. Therefore, this study aimed to observe the properties and characteristics of anti-bacterial liquid soap with *pandan wangi* leaf extract against *Escherichia coli* and *Staphylococcus aureus.*

METHODS

Materials and Tools

The main ingredient used in this study was old *pandan wangi* leaves which were predicted to have higher anti-microbial substances than young *pandan wangi* leaves (Jovanti et al., 2023). *Pandan wangi* leaves were taken from Sorek Satu, Pangkalan Kuras District, Pelalawan Regency, Riau Province, Indonesia. The criterion for old *pandan wangi* is dark green with hard leaf bones (Nofikasari et al., 2016). Other ingredients used were distilled water, 96% ethanol, Golden Khallazz brand virgin coconut oil (VCO), 30% KOH, glycerin, cocamide diethanolamine (DEA), propylene glycol, phenolphthalein indicator, 0.1 N HCl, Nutrient Broth (NB), and Nutrient Agar (NA). The bacteria used in this study were *Staphylococcus aureus* FNCC-15 and *Escherichia coli* FNCC-19, obtained from the Agricultural Product Analysis Laboratory, Riau University, Pekanbaru.

The tools used in this study were FAVORIT hot plate stirrer type P22008 with analog heater, viscometer tester model NDJ-8S, Alla France brand mercury rod thermometer, analog autoclave brand ALL American type 1925X, and Klin Pak brand aluminum foil.

Research Design

The method used was an experimental method using a non-factorial completely randomized design (CRD) consisting of five treatments with three replications to obtain 15 experimental units. The treatment of adding *pandan wangi* leaf extract in this study refers to Apriliani et al. (2018). *Pandan wangi* leaf extract used for making soap in this study was 1.5, 2.0, 2.5, 3.0, and 3.5 grams.

***Pandan Wangi* Leaf Extraction**

Pandan wangi leaf extraction refers to Apriliani et al. (2018). The material used was old *pandan wangi* leaves with criteria of dark green color with hard leaf bones. *Pandan wangi* leaves were washed using running water then were cut into ± 2×2 cm sizes. *Pandan wangi* leaves were dried in a drying oven for 12 hours at 60 ℃. Dried *pandan wangi* leaves were mashed using a blender to form powder (simplicia). 250 g of *pandan wangi* leaf powder was put in a clear glass jar and soaked in 96% ethanol solvent with a ratio of 1:10 (w/v). Soaking was carried out 2 times, with the first soaking being carried out for 1 × 24 hours per one soaking. Then it was replaced with a new soaking agent to optimize the extraction of *pandan wangi* leaves (Wildan, 2010). The soaked mixture was then filtered to obtain the filtrate. The filtrate was separated using a rotary vacuum evaporator at 60°C to obtain a viscous extract of ±12% of the total filtrate.

Liquid Soap Making

Making liquid soap refers to Atmanto (2019). The process of liquid soap making was carried out by heating 25 g of VCO at a temperature of ± 75 ℃ for 15-30 minutes. 17.5 g of 30% KOH was added to the heated VCO and then homogenized. The homogenization result is heated at 75°C until the solution becomes thicker, called soap paste. 44.76 g of distilled water, 3.42 g of glycerin, and 7.5 g of propylene glycol were added to the soap paste, then stirred until homogeneous and heated at 75°C until all ingredients were mixed homogeneously. 1.82 g of cocamide DEA was added and then stirred until homogeneous. *Pandan wangi* leaf extract was added according to the treatment and then stirred until homogeneous.

Physicochemical Characteristics of Liquid Soap

The physicochemical tests carried out in this study consisted of testing the formed foam stability, specific gravity, viscosity, pH, free alkali content, and skin irritation test of the soap. Descriptive and hedonic sensory tests were also carried out on the aroma of soap to see the physical characteristics of the aroma of soap and the panelists' acceptance of the aroma of *pandan wangi* liquid soap. The scores used in the descriptive and hedonic sensory tests are shown in Table 1.

Table 1. Descriptive and hedonic scores on sensory test

Score	Descriptive Criteria	Hedonic Criteria
1	No aroma of *pandan wangi*	Dislike very much
2	A little aroma of *pandan wangi*	Dislike
3	Slight aroma of *pandan wangi*	Slightly like
4	Aroma of *pandan wangi*	Like
5	Very strong aroma of *pandan wangi*	Like very much

Anti-bacterial Activity Test

The anti-bacterial activity of liquid soap was tested by looking at the clear zone that formed on the media (Damayanti et al., 2019). Paper discs were dipped in liquid soap and placed on the inoculated medium pathogenic bacteria. The pathogenic bacteria used were *Escherichia coli* and *Staphylococcus aureus*.

Data Analysis

The data obtained were analyzed statistically using Analysis of Variance (ANOVA). If the value of F Count ≥ F Table, the analysis was continued using Duncan's Multiple Range Test (DMRT) at the 5% level. Data analysis was processed using the Statistical Program for Social Science (SPSS) 16 software application.

RESULT AND DISCUSSION

The results of the physicochemical analysis of liquid soap can be seen in Table 2.

Table 2. Average physicochemical test of liquid soap with the addition of *pandan wangi* leaf extract

Treatment	Foam stability (%)	Specific gravity (g/ml)	Viscosity (mPas)	pH	Total free alkali (%)	Irritation test
Pandan wangi leaf extract 1.5 g (S1)	69.96 [a]	1.0517 [a]	227.1 [a]	9.38 [d]	0	0
Pandan wangi leaf extract 2.0 g (S2)	73.25 [b]	1.0537 [a]	239.3 [a]	9.35 [d]	0	0
Pandan wangi leaf extract 2.5 g (S3)	77.21 [c]	1.0551 [a]	252.4 [a]	9.25 [c]	0	0
Pandan wangi leaf extract 3.0 g (S4)	79.52 [cd]	1.0588 [a]	260.1 [a]	9.15 [b]	0	0
Pandan wangi leaf extract 3.5 g (S5)	81.52 [d]	1.0596 [a]	271.7 [a]	9.02 [a]	0	0

Numbers followed by the same letter are not significantly different at 5% DMRT

Foam Stability

Table 2 shows that the liquid soap foam stability range between 69.96-81.52%. Based on the DMNRT analysis, the foam stability in the S5 treatment was significantly different from the S1, S2, and S3 treatments but not significantly different from the S4 treatment. The stability of liquid soap foam increased with *the pandan wangi* leaf extract addition. This result is caused by saponins in *pandan wangi* leaf extract.

The effect of saponins, active compounds in *pandan wangi* leaf extract, causes an increase in foam stability. Foam can form because saponins have the property of lowering the surface tension of water. Saponins have large molecules that contain hydrophilic and lipophilic group in water, so the adsorption of saponin molecules on the water surface can reduce the water surface tension, which lead to foam formation. The low surface tension causes the surface layer to be easily disturbed, so the ability to form foam is greater (Wang et al., 2019). Sukeksi et al. (2018) stated that saponins have foam-like properties. Shaking with water will form a foam that can last a long time. A more durable foam will increase the stability of the foam.

Another factor that affects the foam formation in liquid soap is the fatty acid content in the oil. The oil used in this research is virgin coconut oil (VCO). VCO is a vegetable oil with easy saponification characteristics (Widyasanti & Ramadha, 2018). VCO contains a component of a simple saturated fatty acid chain (lauric acid) which plays a greater role in soap foam production than long-chain saturated fats. The more foam produced, the more total lauric acid is used to make soap (Asemave & Edoka, 2021). Lauric acid is a good saturated fatty acid often used in soap formulations. Using lauric acid as a raw material will produce a soap with high solubility and good foam characteristics(Ahmed et al., 2022).

Specific Gravity

The specific gravity of each treatment in this study did not show a significant difference because the specific gravity of *pandan wangi* leaf extract was small, so it did not affect the liquid soap's specific gravity. Each raw material added to the liquid soap formulation would determine the soap's specific gravity. The higher the raw material is added to the liquid soap, the specific gravity of the liquid soap will be higher (Agustin et al., 2020).

Table 2 shows that the specific gravity of liquid soap in all treatments meets the Indonesian National Standard (SNI 06-4085-1996. Sabun Mandi Cair, 1996) criteria, which range between 1.01-1.10 g/ml. According to Bratovcic et al. (2018), a specific gravity test needs to be carried out to determine the effect of the ingredients used in the liquid soap formulation on the liquid soap specific gravity. The liquid soap specific gravity affects the liquid soap viscosity value. Another factor that affects the specific gravity of liquid soap is viscosity. The solids and molecules of a solution decrease if the solution is increasingly dilute, thereby reducing its specific gravity (Wulandari et al., 2018).

Viscosity

The viscosity test result in this study (Table 2) shows that *pandan wangi* leaf extract addition was not significantly different in viscosity. It was because the solid components of *pandan wangi* leaf extract were added low so that the cohesion power of liquid soap does not increase. Cohesion forces in a solution will affect the product viscosity (Wahyuni & Dhora, 2019). The viscosity produced in this study was relatively lower than the palm oil-based liquid soap viscosity in the research of Saputra et al. (2014) with a viscosity value of 728.43-1778.75 cP. According to Wulandari et al. (2018), crude oil-based liquid soap with a higher saturated fatty acid composition will have a lower viscosity. The liquid soap viscosity will be high if the unsaturated fatty acid content is also high. Liquid soap viscosity will affect consumer acceptance because consumers will be sure to choose a more viscous liquid soap (Muthmainnah et al., 2016).

Acidity Degree (pH)

Table 2 shows that the liquid soap’s degree of acidity decreased with the addition of *pandan wangi* leaf extract. The decrease was due to *the pandan wangi* leaf extract in this study having a pH value of 5.15, which is included in the acid category. Treatments S1 and S2 did not show a significant difference in the pH of liquid soap, while treatments S3, S4, and S5 showed significant differences. This result was due to the very small concentrations added to the S1 and S2 treatments (1.5 g and 2 g), which were insufficient to lower the liquid soap's pH. Additions above 2.5 g (S3) showed a significant decrease in pH, presumably due to the high acidity in the *pandan wangi* extract, which affects the decrease in the pH of the liquid soap.

The increased acidity causes fatty acids to bind with alkalis, so the soap's pH drops (Sansena et al., 2018). Wulandari et al. (2018) stated the low degree of acidity in the liquid soap was caused by the essential oil of Bangle rhizome having an acidic pH of around five, so that it was able to lower the pH as the concentration of Bangle rhizome essential oil increased. The amount of acid in *pandan wangi* leaf extract will affect the pH of the soap to drop. *Pandan wangi* leaf extract contains several acidic compounds, namely citric acid, malic acid, and tartaric acid (Sansena et al., 2018).

Sany et al. (2019) stated that soap’s pH could be controlled by adding acids, such as citric acid, stearic acid, carboxylic acid, and hydrochloric acid, which can lower the soap’s pH. The pH value of liquid soap obtained in this study was between 9.02-9.38, which met the Indonesian National Standard (SNI 06-4085-1996. Sabun Mandi Cair, 1996) criteria, which should range from 8 to 11. Soaps with very high or low pH values can dry out the skin. Nurrosyidah et al. (2019) stated that cosmetic products with very high or very low pH could increase the adsorption capacity of the skin, causing skin irritation (boils and itching or peeling).

Total of Free Alkali

Table 2 shows that each liquid soap treatment does not contain alkalis or free bases. These results are in accordance with Jayathilaka & Seneviratne (2022) which stated that all the bases used are related to the oil phase in soap paste making. The free base has been neutralized with stearic acid because stearic acid is the agent used as a neutralizer.

The amount of liquid soap-free alkali obtained from *pandan wangi* leaf extract complies with the Indonesian National Standard (SNI 06-4085-1996. Sabun Mandi Cair, 1996), of which the free alkaline content is not allowed to exceed 0.1%. Excessive levels of free alkali in the body wash will cause the skin to become dry and irritated (Febriani et al., 2021).

According to Widyasanti & Ramadha (2018), adding the water ratio to soap causes a decrease in free alkalis because water can reduce the free alkalis concentration in soap. Predianto et al. (2017) stated that excess alkali is undesirable in soap because it causes a burning feeling on the skin when soap is used. A lack of alkali is also not expected because the fatty acids are not saponified by sodium hydroxide, causing free fatty acids excess. Soap tends to smell rancid if the free fatty acid content is high.

Irritation Test

The Irritation test was carried out by applying soap to several points on the skin of the panelists' hands and looking for irritation signs afterward, as indicated by a reddened skin color (Nugrahaeni et al., 2016). The irritation index is divided into four groups, consisting of negligible (0-0.4), slight irritation (0.5-1.9), moderate irritation (2-4.9), and severe irritation (5.0-8.0) (Suharsanti & Ariyani, 2018). The irritation index results of all treatments were 0. It means the soap is categorized as the negligible irritation group. *Pandan wangi* leaf extract liquid soap is considered safe. The liquid soap formulation made in this study did not contain components that could irritate the skin. The results of this study were in accordance with research by Apriliani et al. (2018) which showed that using a concentration of 0-4% *pandan wangi* leaf extract in each treatment did not cause skin irritation.

Skin irritation can be caused by too high or too low a soap's pH and high free alkali content. A study by Wulandari et al. (2018) stated that one of the causes of skin irritation is that the produced soap's pH is relatively higher than human skin's. The pH of the soap produced in this study is between 9.02-9.38, in accordance with SNI, which stipulates that the pH of soap is around 9 (SNI 06-4085-1996. Sabun Mandi Cair, 1996). A high pH of soap can cause the skin become dehydrated and look dry. Simbolon et al. (2018) stated that skin sensitivity in each person can vary depending on skin health, hormones, and genetics. The irritating characteristic of soap also depends on how long the soap has been on the skin and the skin's ability to absorb soap. If the absorption ability of the skin increases, materials needed by skin are hindered to enter the skin, causing the skin to crack and dry (Nurrosyidah et al., 2019).

Sensory Test

Table 3 shows that the aroma in this study was influenced by the raw materials used. The active compound from *pandan wangi* leaf extract has a distinctive aroma. According to Bhuyan & Sonowal (2021), the active compounds in *pandan wangi* aroma are 2 - acetyl - 1 - pyroline (ACPY) and 3-methyl-2(5H)-furanone. These compounds give a distinctive aroma to liquid soap with the addition of *pandan wangi* extract. The more *pandan wangi* leaf extract is used, the more aroma of the *pandan wangi* leaves in the liquid soap will be produced.

Table 3. The average liquid soap aroma test

Treatment	Score	
	Descriptive	Hedonic
Pandan wangi leaf extract 1.5 g (S1)	3.24 [a]	3.13 [a]
Pandan wangi leaf extract 2.0 g (S2)	3.60 [a]	3.43 [ab]
Pandan wangi leaf extract 2.5 g (S3)	3.64 [a]	3.63 [bc]
Pandan wangi leaf extract 3.0 g (S4)	4.12 [b]	3.87 [c]
Pandan wangi leaf extract 3.5 g (S5)	4.16 [b]	3.87 [c]

Numbers followed by the same letter are not significantly different at 5% DMRT

Table 3 shows that the increase in the *pandan wangi* extract addition was descriptively felt by the panelists with a stronger aroma. The addition of 3.0 g of *pandan wangi* leaf extract became the difference threshold, considered as the smallest concentration felt by the panelists to differentiate between treatments. Panelist preferences for each treatment are subjective in hedonic aroma analysis. The suitable aroma chosen by one person may not suit another (Nurrosyidah et al., 2019). Hedonic observations showed that adding *pandan wangi* leaf extract at concentrations above 3.0 g was the preferred aroma of most panelists. Panelists liked the smell of liquid soap in this study because of the *pandan wangi* leaves fragrant aroma.

Anti-bacterial Activity Test

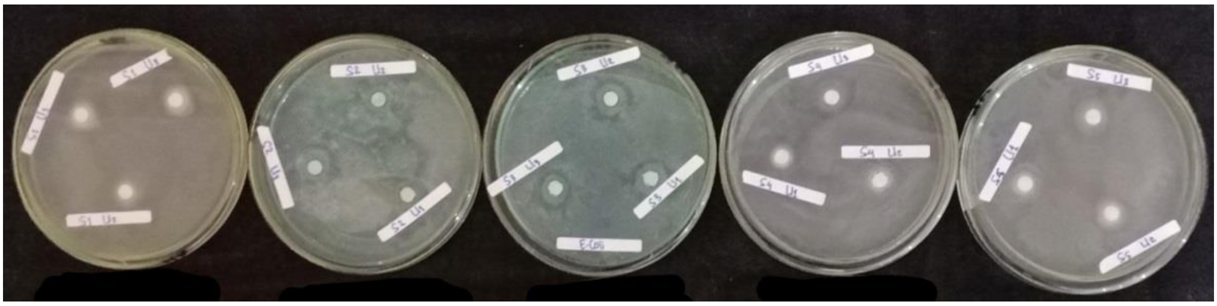
Anti-bacterial activity in *pandan wangi* leaf extract liquid soap was indicated by the formation of inhibition zone, shown in Figure 1. Table 4 shows that *pandan wangi* leaf extract can inhibit the activity of *Escherichia coli* and *Staphylococcus aureus,* indicated by the inhibition zone diameter, which increased with increasing concentration of *pandan wangi* leaf extract. The inhibition zone is formed due to active compounds with anti-bacterial activity (Rajivgandhi et al., 2020). The mechanism of the anti-bacterial action of each active compound is different. These active compounds inhibit bacteria growth, which begins by damaging the cell wall. The active compound inhibits the bacteria growth more strongly if the diameter of the inhibition zone formed is longer. According to Jacky et al. (2019), the anti-bacterial activity that formed the inhibition zone was due to *pandan wangi* leaf extract, which contains active compounds of alkaloids and flavonoids.

Table 4. Average anti-bacterial activity of *pandan wangi* liquid soap

Treatment	Inhibition zone (mm)	
	Escherichia coli	***Staphylococcus aureus***
Pandan wangi leaf extract 1.5 g (S1)	5.11 ^{a}	6.44 ^{a}
Pandan wangi leaf extract 2.0 g (S2)	6.44 ^{b}	8.22 ^{b}
Pandan wangi leaf extract 2.5 g (S3)	8.22 ^{c}	9.11^{bc}
Pandan wangi leaf extract 3.0 g (S4)	9.78 ^{d}	9.56 ^{c}
Pandan wangi leaf extract 3.5 g (S5)	11.22 ^{e}	12.22 ^{d}

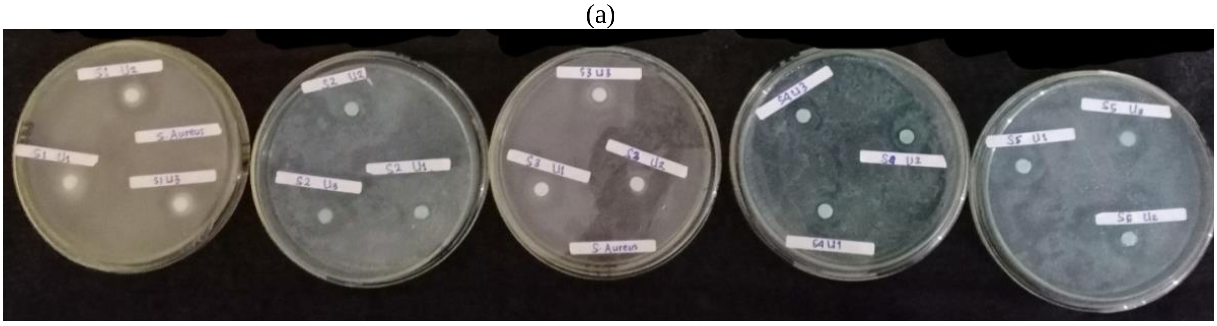
Numbers followed by the same letter are not significantly different at 5% DMRT

The inhibition zone of *pandan wangi* leaf liquid soap on *Escherichia coli* ranged between 5.11-11.22 mm, while the inhibition zone of *pandan wangi* leaf liquid soap on *Staphylococcus aureus* ranged between 6.44-12.22 mm. The *Escherichia coli* inhibition zone showed that each treatment differed significantly. The inhibition zone of *Staphylococcus aureus* showed that the results of treatments S1 and S5 were significantly different from other treatments. In contrast, treatment S2 was not significantly different from S3, and treatment S3 was not significantly different from S4.



Pandan wangi leaf extract 1.5 g (S1) | Pandan wangi leaf extract 2.0 g (S2) | Pandan wangi leaf extract 2.5 g (S3) | Pandan wangi leaf extract 3.0 g (S4) | Pandan wangi leaf extract 3.5 g (S5)

(a)



Pandan wangi leaf extract 1.5 g (S1) | Pandan wangi leaf extract 2.0 g (S2) | Pandan wangi leaf extract 2.5 g (S3) | Pandan wangi leaf extract 3.0 g (S4) | Pandan wangi leaf extract 3.5 g (S5)

(b)

Figure 1. Inhibition Zone of *Pandan Wangi* Leaf Extract Liquid Soap on *Escherichia coli* (a) and *Staphylococcus aureus* (b)

The results of the inhibition zone showed that liquid soap with the addition of *pandan wangi* leaf extract was more effective in inhibiting the *Staphylococcus aureus growth* than *Escherichia coli growth*.

It was indicated by the formation of a larger inhibition zone around the *Staphylococcus aureus* bacterial media compared to the *Escherichia coli* bacterial inhibition zone in each treatment. This difference was caused by the bacterial cell wall difference. *Escherichia coli* is a gram-negative bacterium that has a thinner and more complex cell wall with a high lipid content that makes it difficult to penetrate. *Staphylococcus aureus* is a gram-positive bacterium that has a simple cell wall, thick, single-layered, low-fat, and the cytoplasmic membrane layer is composed of peptidoglycan and teichoic acid in the form of water-soluble polymers so that gram-positive bacteria are more easily penetrated by polar substances from the media (Noviyandri et al., 2018).

Nurlila et al. (2021) stated that the criteria for the strength of antibacterial activity are categorized based on the diameter of the inhibition zone formed, as shown in Table 5. Liquid soap from *pandan wangi* leaf extract in this study had an inhibitory effect on *Escherichia coli* bacteria and *Staphylococcus aureus* bacteria in the medium-strong category.

Table 5. The strength of the anti-bacterial power based on the diameter of the inhibition zone

Inhibition zone diameter (mm)	Category
5	Weak
5-10	Moderate
10-20	Strong
≥ 20	Very strong

CONSLUSIONS

The *pandan wangi* leaf extract addition into the liquid soap formulation significantly affects foam stability, degree of acidity, anti-bacterial activity test, and sensory test descriptively and hedonic. The results showed that treatment S5 (addition of *pandan wangi* leaf extract 3.5 g) was the best treatment because it had an anti-bacterial inhibition zone for *Escherichia coli* of 11.22 mm, and *Staphylococcus aureus* of 12.22 mm, foam stability of 81.52%, specific gravity 1.0596 g/ml, viscosity 271.7 mPas, degree of acidity 9.02, total free alkali 0%, does not cause irritation to the skin, aroma of pandan and is liked by the panelists.

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