Quality Characteristics and Antibacterial Activity of Transparent Solid Soap with Addition of Cananga Oil (*Cananga odorata*)

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Abstract: Cananga oil (*Cananga odorata*) is a natural source of fragrances that can be used as an antibacterial agent, so cananga oil can be added to the formulation for making antibacterial soap. Therefore, the aim of this study is to determine the formulation of cananga soap using different types of oil and to characterize the quality of transparent solid soap. This study uses a completely randomized design (CRD) with a factorial pattern consisting of two factors and three replications. Oil type (VCO and palm oil) and cananga oil concentration (0% (control), 0.5%, 1%, and 1.5%; w / v) were factors in this study. Moisture content, free alkali content, pH, hardness, foam stability and antibacterial activity were analyzed. *Staphylococcus aureus* and *Escherichia coli* were used to test antibacterial activity. The results showed that soap made from VCO oil and 1.5% cananga oil was the best formulation. The characteristics of transparent solid soap are water content 1.81-4.39%, free alkali content 0.63-0.96%, pH 11.33-11.81, hardness 0.042 - 0.065 mm / g / s, and foam stability 69.70-85.45%. However, soaps made from VCO were only able to inhibit the growth of *Staphylococcus aureus* with inhibitory diameters of 8.1-11.0 mm. Further research is needed to reduce the levels of free alkali in soap and to increase the concentration of cananga oil so that it can inhibit the growth of *Escherichia coli*.

1 INTRODUCTION

Soap is a product of fatty acids and strong alkali salts (sodium or potassium) hydrolysis. There are two forms of soaps which are bar and liquid. Bar soap is divided into 3 types, namely opaque, translucent and transparent solid soaps. Transparent solid soap has the highest level of clarity where this soap can be penetrated by light (Prihandana et al., 2007). Transparent solid soap has more excellence compared to opaque soap specifically in its clear appearance and its softer foam because diethanolamine cocoamide, alcohol and sugar solution were added during production. Also, high concentration of glycerine was added giving the transparent solid soap moister.

The types of fatty acid of the raw materials used in production of transparent solid soap influence the characteristics of the soap produced (Momuat et al., 2017). Fatty acids are the major component which is made up from fat so selection of the fat in the soap production is very important. The types of fatty acids used in making transparent soap can come from VCO oil and palm oil (Widyasanti, 2016), coconut oil (Rozi, 2013), used cooking oil (Priani, 2010), VCO and olive oil (Febriyenti, 2014).

Nowadays, transparent solid soap produced with addition of natural ingredients is in great demand by consumers especially because of beneficial effects on skin health. Many synthetic antibacterial ingredients such as triclosan and chloroxylenol are used to produce antibacterial soaps (Wijana et al., 2019). Unfortunately, the use of chemical soap continuously can cause antibiotic resistance (Roslan et al., 2009). Natural antibacterial alternatives are needed in soap production.

In this research, cananga oil was added as essential oil because cananga is a local flowering plant in Aceh Province, Indonesia. In Indonesia, in addition to being used as flowers for the ceremonial cananga become the identity flora of the Province of Nanggroe Aceh Darussalam and North Sumatra Province (Sotyati, 2016). It has a distinctive and fragrant flower aroma. The chemical composition of cananga oil is α-humulene (7.1%), germacrene D (8.1%), α-farnesene (12.6%), farnesol (5.6%) and benzyl benzoate (3.8%). The main components that

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contribute to the aroma of cananga oil are linalool (8.7%), dan β-caryophyllene (26.8%) (Giang and Son, 2016). Cananga has also been used for antibacterial, anti-inflammatory and local anesthetic activity (Erindyah, 2002).

Cananga oil has the ability to inhibit the growth of *Staphylococcus aureus* bacteria. Activity against bacteria continued to increase in accordance with the amount of antibacterial compounds in the oil (Maulidya, 2016; Anggia et al., 2014). The components of O-methylmoschatoline, liriodenine (24%), 3,4-dihydroxybenzoic acid, germacrene D (11%), and β-caryophyllene (12%) have been investigated to contribute in antimicrobial activity (Tan et al., 2015). The use of cananga oil serves not only as a substitute for synthetic antibacterial substances, but also as a fragrance in transparent solid soap.

Therefore, the purpose of this study was to determine the cananga soap formulation as well as to characterise the quality of the transparent solid soap. The raw materials used were palm oil and virgin coconut oil (VCO). Also, cananga oil was used in various concentration (0.5%, 1%, 1.5%).

2 MATERIALS AND METHODS

2.1 Material

The materials used in this study were cananga oil, virgin coconut oil (VCO), palm oil, stearic acid, NaOH, glycerin, ethanol, sugar solution, NaCl, diethanolamine cocoamide, aquadest, nutrient agar (Merck®), commercial antibacterial soap, *Staphylococcus aureus* and *Escherichia coli.*

2.2 Research Design

This study used a completely randomized design (CRD) with a factorial pattern consisting of two factors. The first factor was types of oils (M) consisting of two levels (VCO (M1) and palm oil (M2)). The second factor was cananga oil concentration (K; w/v) consisting of four levels (0% (K1; control), 0.5% (K2), 1% (K3) and 1.5% (K4).

2.3 Transparent Soap Production

The oils (coconut oil and palm oil) were heated at 70°C. Stearate acid and NaOH 30% were added and mixed until homogeneous to produce soap stocks. Ethanol, glycerin, sugar solutions, sodium chloride, and diethanolamine cocoamide were added to the soap stock and stirred constantly for 10 minutes until the mixture became homogeneous and clear solution was formed. Cananga oil (0.5%, 1%, 1.5%) was added to the soap mixture at 40°C and was stirred until homogeneous. The soap mixture was molded in a transparent solid soap mold. Furthermore, the curing process took for 3 weeks.

2.4 Analysis of Transparent Soap

The chemical (water content, free alkali level, pH) and physical (hardness and foam stability) properties were examined following Indonesia National Standard (SNI 06-4085-1996). The soap was examined for antibacterial testing on *Escherichia coli* and *Staphylococcus aureus* (Widyasanti, 2016). The antibacterial ability was observed by measuring the inhibitory area around the media which had been placed on disc paper, which was marked by the presence of a clear zone. The clear zone formed is measured using a callipers.

2.5 Statistical Analysis

Data from water content, free alkali content, pH test, hardness and foam stability were analysed with analyse of variance (ANNOVA). The level used in this analysis was 5%. If there is a significant effect between treatments, Least Significance Different (LSD) was used as the post hoc test to find out the differences between treatments.

3 RESULTS AND DISCUSSION

3.1 Chemical Properties of Transparent Solid Soap

3.1.1 Water Content

Based on SNI 06-3532-1994, the maximum moisture content in soap is 15%. The amount of water contained in soap can affect the characteristics of the soap during the storage period. Soap with a high water content or > 15% will experience a decrease in weight and dimensions (Fachmi, 2008). Based on the analysis of variance, it is known that the type of oils has a very significant influence on the water content of the transparent solid soap produced. The percentage of water content can be seen in Figure 1. This result showed that the moisture content of transparent solid soap made from VCO and palm oil met the SNI.

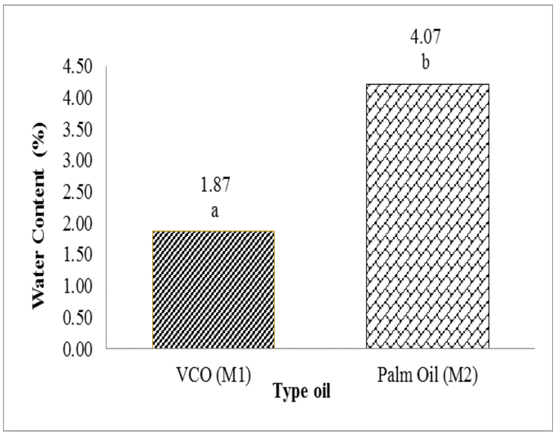

Figure 1: Percentage of water content of transparent solid soap at different type of oils. The notation followed by the same letter shows no difference ($LSD_{0.05}$ = 0.41 and coefficient of variation = 15.60%).

Water content is an important quality parameter on transparent soaps. High water content causes an increase in rancidity in transparent soap products. The type of oil in each treatment is sensitive to water content. The amount of water and volatile substances in soap will affect the solubility of soap in water when used (Karo, 2011). The transparent soap produced has a water content of 1.47% (VCO) and 4.07% (palm oil).

The results of the diversity analysis (α = 0.05) showed that the treatment of oil type had a very significant effect on the water content of transparent soap. Duncan's further test results show that the water content of soap in this type of coconut oil is different from soap made from VCO oil. Fatty acids that react with NaOH will form soap and water. In addition, the increase in water content can be caused by the end result of oxidation of fatty acids contained in soap which produces volatile aldehyde and ketone compounds (Karo, 2011). So that soap from VCO oil has a lower moisture content value than soap from palm oil. The highest saturated fatty acid in palm oil is palmitate acid, and VCO is lauric acid.

3.1.2 Free Alkali Level

Free alkali is alkali in soap which is not needed during the sapling process (SNI, 1996). Free alkali levels obtained from this study were 0.64% -0.93%, so as to increase the pH of the soap. The maximum free alkali level is 0.1% (SNI, 1996). Soaps that have high free alkali levels or > 0.1% can cause skin irritation (Fachmi, 2008). Based on the analysis of variance, it is known that the concentration of canaga oil has a very significant influence on the free alkali level of the transparent solid soap produced. The percentage of free alkali level can be seen in Figure 2.

Based on Figure 2, the value of alkali levels increases with increasing cananga oil concentration. The excess alkali in soap is thought to be caused by the chemical component of ylang oil containing alkaloid compounds. The typical chemical composition of cananga oil generally consists of five main components, caryophyllene (29.60%), germacrene-D (19.22%), geraniol acetate (10.79%), bergamotene (7.97%), α-humulent (7.97%) 7.77%).

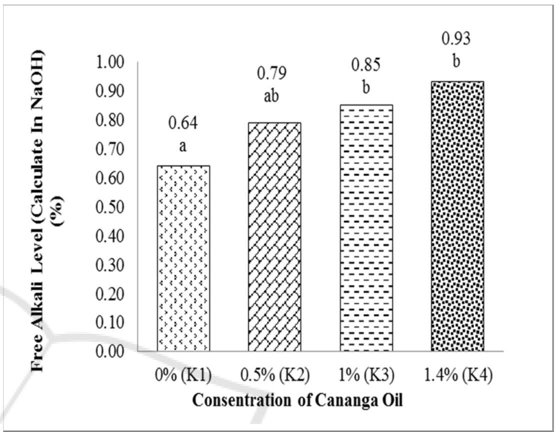

Figure 2: Free alkali levels of transparent solid soap at different cananga oil concentrations. The notation followed by the same letter shows no difference ($LSD_{0.05}$ = 0.16 and coefficient of variation = 15.81%).

Free alkali levels of soap products produced are quite high, this is presumably because cananga oil contains alkaloid compounds. Alkaloids are organic compounds that are basic or alkaline (Lenny, 2006). Most alkaloids at room temperature are generally in the form of colourless crystals and are volatile. Alkaloids are generally soluble in water, but some are soluble in organic solvents. Most alkaloids are weak bases, and some are amphoteric. (Babbar 2015). The main components that contribute to the aroma of cananga oil are linalool (8.7%) and β-caryophyllene (26.8%). This is because linalool is a compound that gives a distinctive aroma (Oktapiyani, 2004).

3.1.3 pH

The results of pH measurements can be seen in Figure 3. The type of oil has a very significant effect on the value of pH. The pH value obtained in VCO oil is around 11.34 and palm oil is 11.69. The pH values have met the quality criteria for bath soap ranging from 9-11 (Hambali, 2005). The final pH value of the product is strongly influenced by the basic ingredients used (Rahmanto, 2011). In addition, pH measurements in the range 9-11 are relatively safe for the skin (Edoga, 2009).

This pH instability can most likely be caused by a heating factor, due to the hydrolysis of the active ingredient of sodium ester with fatty acids so that it can cause free alkali which can increase the pH of soap (Nurhadi, 2012). The pH of alkaline soap can help the skin in opening pores and dirt that sticks to the skin, bound by foam contained in the soap (Setyoningrum, 2010).

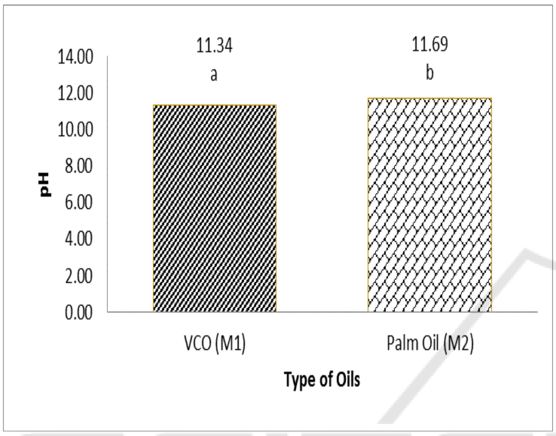

Figure 3: pH value of transparent solid soap at different type of oils. The notation followed by the same letter shows no difference ($LSD_{0.05}$ = 0.26 and coefficient of variation = 2.65%).

The pH on VCO is lower than that of palm oil. It is thought that the difference in the fatty acid carbon chain can affect the low VCO pH value. Addition of weak fatty acids, such as citric acid, can reduce the pH of soap (Wasitaatmadja, 1997). Fatty acids in VCO (lauric acid) have shorter chains when compared to fatty acids in palm oil (palmitic acid). This pH instability is most likely caused by a heating factor, due to the hydrolysis of the active ingredient of sodium ester with fatty acids so that it can cause free alkali which can increase the pH of soap (Nurhadi, 2012).

3.2 Physical Properties of Transparent Solid Soap

The production of transparent soap made with various concentration of cananga oil were made on the basis of 300 g. During the production, the soap loses 100g. This was expected due to the amount of foam produced before the printing process so that a lot of foam was removed when the foam was separated with the soap mixture. The resulting soap can be said transparent if when the soap is placed on paper with 12 font size, the letters can be read clearly. The transparent soap produced in each treatment can be seen in Figure 4.

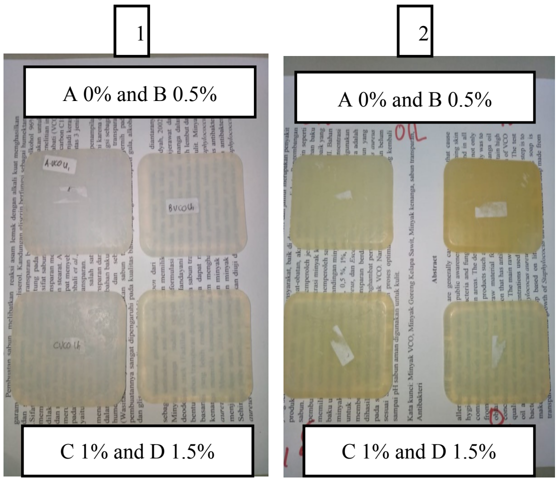

Figure 4: Transparent soaps made from: 1) virgin coconut oil and 2) palm oil at various concentration of cananga oil.

Based on Figure 4 the VCO soap is more transparent compared to the palm oil soap. Transparent soap can be produced in several different ways. One of the oldest methods is by dissolving the soap in alcohol with gentle heating to make a clear solution which is then given a fragrance and coloring. The color of the bar soap depends on the choice of starting material and if good quality soap is not used, it is likely that the final product will be very yellow in color (Williams, 2002). The basic ingredients of VCO soap have a clear color while palm oil has a yellowish color. This is thought to be the cause of the transparent soap from VCO becoming more clear when compared to palm oil.

3.2.1 Hardness

The hardness of transparent solid soap can be influenced by saturated fatty acids which are used as raw materials in making transparent solid soap. The results of variance indicate that the type of oil affects the hardness in soap. Hardness of transparent solid soap can be seen in Figure 5.

From Figure 5, the type of oil in this study affects the value of soap hardness. Factors affecting the hardness of saturated fatty acids and water content values (Widyasanti, 2016). The highest saturated fatty acid in palm oil is palmitate acid, and VCO is lauric acid. Saturated fatty acids are fatty acids that do not have double bonds, saturated fatty acids are usually solid at room temperature, so it will produce a harder soap (Gusviputri et al., 2013). The longer the carbon chain of fatty acids, the fatty acids tend to be solid.

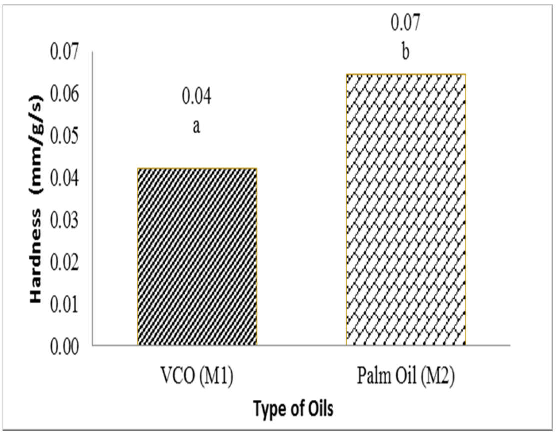

Figure 5: Hardness of transparent solid soap at different type of oils. The notation followed by the same letter shows no difference ($LSD_{0.05}$ = 0.02 and coefficient of variation = 37.94%).

The value of water content from the research results is higher palm oil (4.07%) and lower VCO (1.87%). The higher the amount of water content contained in soap, the higher the level of hardness shown by the penetrometer scale. If the penetrometer scale shows a high number, the soap will be soft (Widyasanti, 2016). If the soap is too soft, it will cause the soap to dissolve easily and become easily damaged (Steve, 2008).

3.2.2 Foam Stability

Foam is one of the important parameters in determining the quality of bath soap. In its use, foam plays a role in the cleansing process on the skin. The results of various analyses show that the concentration of cananga oil added to transparent solid soap does not show a significant difference in the stability value of the foam. While the type of oil used in this study showed a significant effect on the 5% test level on the stability of the soap foam. Foam stability can be seen in Figure 6.

Palm oil contains palmitic acid which is good in maintaining foam stability. The saturated fatty acids found in palm oil are palmitic acid which can function for foam stability (Widyasanti, 2010). Saturated fatty acids contained in soap make foam more stable when compared to unsaturated fatty acids (Gromophone 1983).

However, the water content of products made from palm oil tends to be high, making the foam on the product unstable. So that the foam is more stable in VCO-based soap products. Foam characteristics are also influenced by the presence of soap active ingredients or surfactants, foam stabilizers and soap making materials (Amin, 2006).

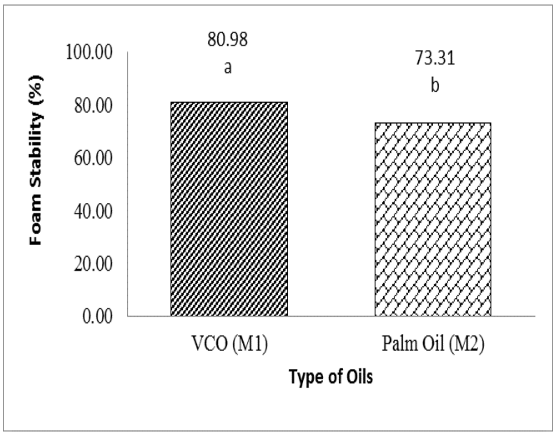

Figure 6: Foam stability of transparent solid soap at different type of oils. The notation followed by the same letter shows no difference ($LSD_{0.05}$ = 4.47 and coefficient of variation = 6.69%).

3.3 Antibacterial Activity of Transparent Cananga Oil

Gram positive bacteria *Staphylococcus aureus* and Gram negative bacteria *Escherichia coli* were used to test the antibacterial effect of transparent solid soap containing cananga oil. These bacteria were selected because these pathogenic bacteria are often found on the hands and skin. The results showed that addition of cananga oil until 1.5% in transparent solid soap production made from VCO and palm oil could not inhibit *E. coli*. The inhibitory effect of *S. aureus* was shown on the soap made from VCO only (Figure 7).

From Figure 7, there is a very significant influence on inhibitory diameter of *S. aureus* because of the interaction between type of oil and cananga oil concentration ranging from 8.07 - 11.00 mm. The inhibition occurred in the VCO oil because this oil contains lauric acid which also has antibacterial effect (Febriyenti, 2014). Antibacterial compounds in soap provide activity in inhibiting bacteria caused because the soap is hydrophilic-lipophilic. Nonpolar groups on soap are -R and -COONa groups which are polar in nature. The hydrophilic nature of soap causes antimicrobial compounds to be able to diffuse in polar agar media, while the lipophilic nature of soap will help the penetration of antibacterial compounds into lipophilic bacterial cell membranes (Pelczar, 1998).

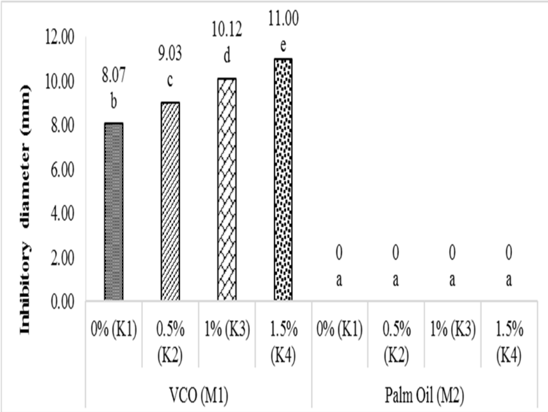

Figure 7: Inhibitory diameter of *Staphylococcus aureus* on transparent solid soap. The notation followed by the same letter shows no difference ($LSD_{0.05}$ = 0.69 and coefficient of variation = 8.37%).

4 CONCLUSIONS

Palm oil and VCO can be formulated into transparent solid soap by adding different concentrations of cananga oil. Physical and chemical analyses showed that the soaps have meet the SNI. Unfortunately, the value of free alkali in soap exceeds the maximum SNI limit and in bacterial inhibition tests, only VCO is significant in *Staphylococcus aureus*. Further research is needed to reduce the levels of free alkali in soap and increase the concentration of cananga oil so that it can inhibit the growth of *Escherichia coli*.

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