Production of Liquid Soap from Castor Oil and VCO with the Addition of Sorghum Tannins and Lemongrass Essential Oil as Anti-Bacterial Ingredients

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Abstract. A good quality of soap must be able to prevent the spread of pathogenic bacteria on the skin; therefore, it is necessary to add anti-bacterial ingredients such as lemongrass essential oil and tannins. The aim of this study is to produce liquid soap from castor oil and VCO with the addition of lemongrass essential oil and sorghum (*Sorghum bicolor* L. Moench) tannins. The effect of adding anti-bacterial ingredients was examined based on the quality and characteristics of the produced soap. The volume of anti-bacterial ingredients (tannins and lemongrass oil) was added using variation of 2; 2.5; 3; 3.5; and 4 mL. The quality and characteristics of the soap were examined using several parameters, namely pH, amount of foam, free alkali content, specific gravity, anti-bacterial activity, and organoleptic analysis. The volume of active ingredients being added will influence quality of the liquid soap. The results of the study indicated that the best conditions for making liquid soap was achieved when applying 4 mL of active ingredients, which resulted in liquid soap with a pH of 9.33 and 9.39, free alkali content of 0.0102 and 0.0163%, specific gravity of 1.059 and 1.071 respectively with active ingredients of sorghum tannins and lemongrass oil. Lemongrass oil is better at inhibiting bacteria than sorghum tannins. Correspondingly, the orga-noleptic results indicated that soap with the addition of lemongrass oil was better when compared to the addition of sorghum tannins. Liquid soap with the addition of lemongrass oil is transparent yellow in color, smells refreshing, produces more foam and is very comfortable to use. Therefore, liquid soap resulting from this study is safe to use because it complies with SNI 06–4085-1996.

Keywords: Anti-bacterial · Castor oil · Lemongrass Oil · Liquid Soap · Sorghum Tannins · Virgin Coconut Oil

1 Introduction

The skin is the part that covers and protects the body's entire external surface from the environment, such as the influence of microorganisms [1, 2]. One of the anti-bacterial

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products required to protect the skin is soap. Soap is defined as an anionic surfactant which is used with water for washing and cleaning. Soap consists of combines fat or oil, water, and alkali organic material which are obtained by reacting between potassium and fatty acids from vegetable and animal oil which produces sodium salts from the hydrolysis of free fatty acids and glycerol in a process called saponification [3]. There are two types of soap, based on the type of alkali being used, namely bar/solid soap or sodium soap and liquid soap or potassium soap.

The use of natural ingredients to produce liquid soap needs to be developed in order to offer a positive impact. One of the natural raw ingredients added in the production of liquid bathing soap is fat or oil derived from vegetables and animals. One of vegetable oils having efficacy for healthy skin are castor oil and virgin coconut oil (VCO) [4]. In order to improve product quality, besides using vegetable-based ingredients, it is also important to add anti-bacterial ingredients. Several varieties of natural anti-bacterial substances include lemongrass essential oil (*Cymbopogon citratus*) and tannins from sorghum seeds (*Sorghum bicolor* L. Moench) [5]. Sorghum is a cereal plant, it contains high starch within range 64.3 to 73.8%, crude protein 8.19 to 14.02%, and bioactive compounds such as tannins 6.77 to 10.66%. Tannins in sorghum are polyphenolic compounds that have antioxidant activity [6]. These compounds have potential if being used as an anti-bacterial agent for *Staphylococcus aureus*.

Lemongrass is a variety of plant which belongs to Graminese family and is an aromatic plant that produces a good scent, thus it can be used for perfumes, deodorants, and soaps [7]. The main components are monoterpenes citral and myrcene which are both antibacterial agents. Lemongrass oil possesses strong anti-fungal and anti-microbial activi-ties [8]. This study will examine the production of liquid soap using natural raw materials, namely castor oil and VCO, with the addition of anti-bacterial ingredients, namely tannins from sorghum seeds and lemongrass essential oil. The main focus of this study is to clarify the effect of volume variations of anti-bacterial ingredients on the characteristics and quality of the liquid soap produced.

2 Research Method

The materials used in this study included castor oil, VCO, lemongrass essential oil, glycerin, distilled water, propylene glycol, coco-diethanolamide (Coco-DEA), and sodium lauryl sulfate (SLS) (obtained from Toko Kimia Indrasari), sorghum tannins (obtained from the hydrolysis process of sorghum seeds), 30% potassium hydroxide (obtained from Laboratorium Terpadu Teknik Kimia UNNES). At first, we weighed all the ingredients accordingly, respectively 60 mg of castor oil; 15 g of VCO; 52.5 g 30% potassium hydroxide; 10.25 g of glycerin; 28.95 g of distilled water; 22.5 g of propylene glycol; 4.46 g of coco-diethanolamide (Coco-DEA); and 4.46 g of sodium lauryl sulfate (SLS) for 1 variation of soap production. The initial production stage was pouring VCO and castor oil into 500 mL beaker glass and then were heated using a water bath at 75 °C and stirred using an overheat stirrer at 400 rpm. After the VCO and castor oil fused (homogeneous), 30% KOH was added while still being heated and stirred. After a while, trace conditions occurred, in which the solution thickened into a paste, then distilled water was added until it became homogeneous again, afterwards glycerin and propylene glycol were added. Once they became homogeneous, the mixture was then cooled to room

temperature, afterwards SLS and coco-DEA were added. Subsequently, the heating and stirring process were carried out again until all the mixture was completely homogeneous. Lastly, the active anti-bacterial ingredients were added, respectively lemongrass essential oil (2; 2.5; 3; 3.5; 4 mL) and sorghum tannins (2; 2.5; 3; 3.5; 4 mL). The total process of stirring and heating took 4 h until it turned into soap. Then the liquid soap was stored for 24 h, to ensure that the mixture did not separate [9].

The next stage was testing the quality of liquid soap. Procedures for testing the chemical and physical properties of liquid bathing soap according to SNI 06–4085-1996 include pH, free alkali content, active ingredient content (total fatty acid), specific gravity, anti-bacterial activity. In addition, a consumer preference test (organoleptic) was also conducted for scent, thickness, amount of foam, impression while applying, and impression after using the liquid bathing soap.

3 Results and Discussion

Figure 1 presents the obtained color of the liquid soap. The resulting liquid soaps have different colors due to the use of different anti-bacterial ingredients. Liquid soap with the addition of tannins produces a transparent brown color, while the addition of lemongrass essential oil produces a transparent yellow color. This is due to the hydro-lysis process when extracting tannins from sorghum seeds, the tannins produced are transparent brown so liquid soap with the addition of tannins also produces a transparent brown color [10]. While the yellow color in liquid soap with the addition of lemongrass essential oil is due to the presence of geraniol compounds in lemongrass essential oil [11]. The results of Kayaputri's extraction [12] showed that the tannins had a yellowish-brown color, whereas according to Rita's extraction [13], lemongrass oil was clear yellow in color.

One of the important parameters of a cosmetic product, because it can affect the absorption capacity on human skin, is pH. The volume of the added anti-bacterial ingredient affects the pH of the resulting liquid soap (see Fig. 2). The higher the amount of tannins added (2 to 4 mL), hence the higher pH level of the soap is (9.02 to 9.33). This is

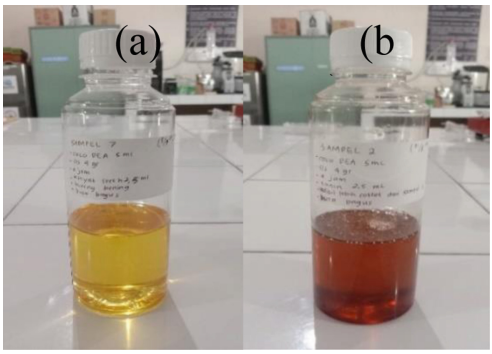

Fig. 1. Color of Liquid Soap from Castor Oil and VCO at 75 °C with the Addition of Anti-bacterial Ingredients. (a) Anti-bacterial Ingredient of Tannins; (b) Anti-bacterial Ingredient of Lemongrass Essential Oil

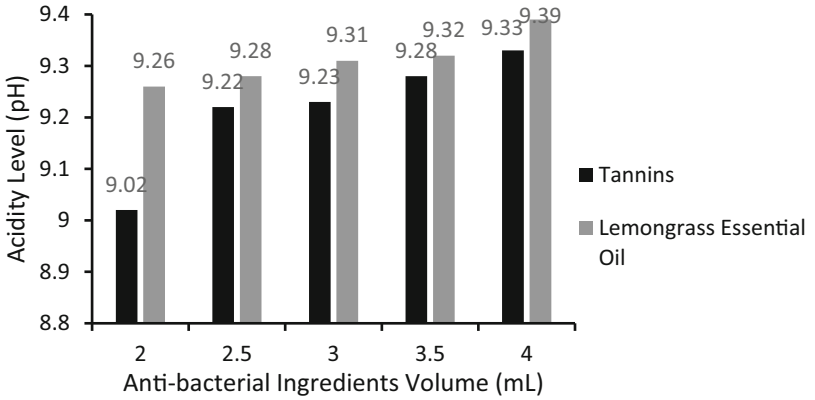

Fig. 2. The Effect of Volume Variation of Anti-bacterial Ingredients (Tannins and Lemongrass Essential Oil) on the pH of Liquid Soap from Castor Oil and VCO at 75 °C

because tannins have acidic properties, so they can neutralize and increase the pH level of alkaline soap [14]. Likewise for the anti-bacterial ingredient of lemongrass essential oil, the higher the amount (from 2 to 4 mL) the higher the pH level of the soap is (9.26 becomes 9.39). Lemongrass essential oil also has acidic properties [15]. The pH range of liquid soap required by SNI is in between 8–11 [16]. Meaning that the pH of liquid soap produced in this study is in accordance to SNI, therefore it is safe to use because it does not cause skin irritation.

Soap with a large amount of foam and is stable for a long interval is highly desired by the public, because it is convenient for cleaning the body [17]. Fig. 3 presents the results of foam height test on various types and volumes of anti-bacterial ingredients. The higher the volume of tannins added (2 to 4 mL), the lower the foam height is (80 to 55). The study indicated that by increasing the amount of tannins can hold the foam. Basically the formation of foam begins when gas bubbles enter the surfactant and then are absorbed at the gas/liquid interface and form gas bubbles wrapped in a film (foam). This foam then rises to the surface because the density of gas is lower than water [18]. Different results were found in the addition of lemongrass oil, in which the higher the volume (2 to 4 mL) the higher the foam is (80 to 95), except at 3.5 mL, the foam height lowered (only 70). Overall, liquid soap with the addition of anti-bacterial tannins and lemongrass essential oil had the amount of foam that is still in accordance with SNI (foam height 13–220 mm). The quality of the foam in liquid soap is influenced by its constituent ingredients, such as the presence of surfactants and foam stabilizers [19]. In this study, the produced liquid soap had been added with surfactants and foam stabilizers, namely sodium lauryl sulfate (SLS) and coco-DEA. Therefore, the composition of the ingredients in this study can produce liquid soap that generates foam acceptable to the public.

Free alkali examination to determine excess free alkali, which can cause skin irritation [20]. The limit of free alkali content in liquid soap is a maximum of 0.1%. The determination of free alkali is carried out by acidimetric titration [16]. In this study, the free alkali contents of each liquid soap generated are as shown in Fig. 4. The higher

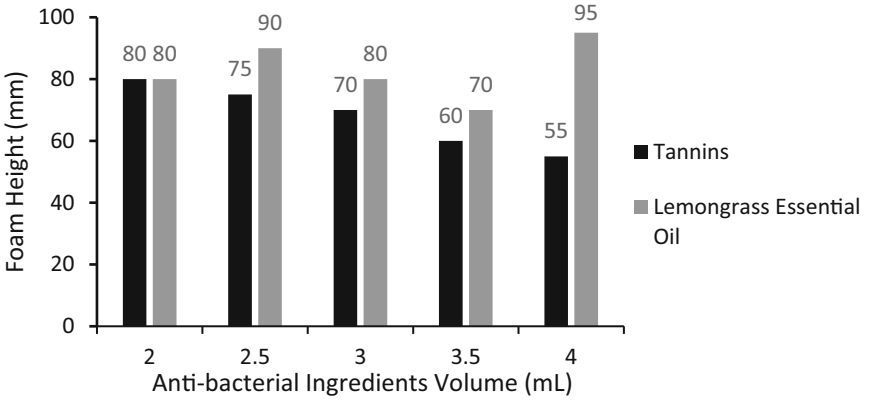

Fig. 3. The Effect of Volume Variation of Actibacterial Materials (Tannins and Lemongrass Essential Oil) on Foaming Height in Liquid Soap from Castor Oil and VCO at 75 °C

the volume of tannins added (2 to 4 mL), the lower the free alkali content is (0.0204 to 0.0081). This is because tannins have deficient acidic properties so that they can reduce the free alkali content of alkaline compounds [21]. Similar results were obtained for lemongrass oil, the higher the volume of lemongrass oil added (2 to 4 mL) the lower the free alkali content obtained (0.0163 to 0.0122). Lemongrass essential oil has acidic properties, so it can reduce the value offree alkali content [22]. Free alkali content in all liquid soap products produced are in accordance with SNI, hence it is safe to use and does not cause skin irritation. The specific gravity of liquid soap from this study was 1.057 as the lowest and 1.071 as the highest. The specific gravity of liquid soap is in accordance with SNI 06–405-1996 which is 1.01–1.10 [16].

Based on the results of the *Staphylococcus aureus* anti-bacterial activity test that has been carried out, anti-bacterial effectiveness can be observed from the formation of bacterial inhibition zones. The measured inhibition zone values can be seen in Table 1. The higher the volume of anti-bacterial ingredients, the larger the diameter of inhibition zone. Liquid soap with the addition of 4 mL of tannins generated an inhibition zone diameter of 35 mm, while the addition of lemongrass essential oil created 46.5 mm of inhibition zone diameter. Lemongrass essential oil was considered to be superior in inhibiting bacterial growth compared to tannins. Sorghum tannins and lemongrass essential oil have flavanoid compounds such as saponins, phenolic acids, and condensed tannins which can inhibit bacterial growth [6]. These phenolic compounds serve as poison to bacteria, so they can inhibit the bacterial growth at high concentrations [23]. Flavonoid compounds can kill bacteria by breaking down bacterial cell walls [24]. Tannins compounds can inhibit the synthesis of bacterial cell walls due to the formation of irreversible complex bonds with prolene protein [25]. The results of the organoleptic analysis indicated that liquid soap with the addition of lemongrass essential oil as an anti-bacterial ingredient was preferred because it had a fresh scent of lemongrass leaves, was thicker, produced lots of foam, was more comfortable to use, and had a longer lasting scent.

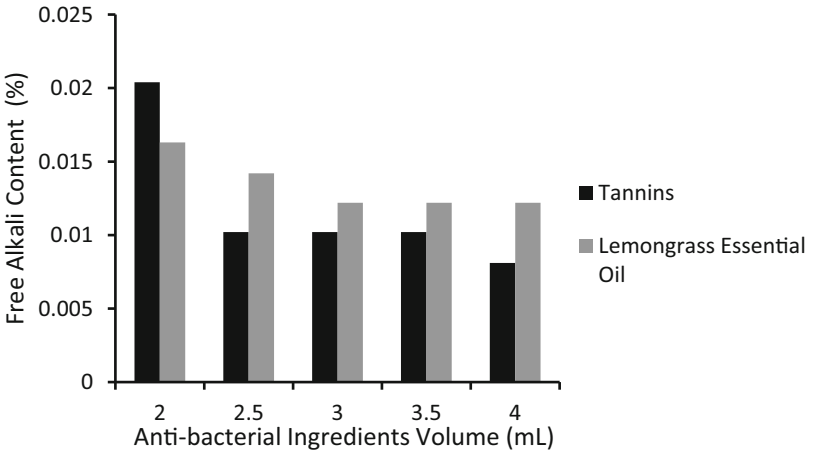

Fig. 4. The Effect of Volume Variation of Acti-bacterial Materials (Tannins and Lemongrass Essential Oil) on Free Alkali Content in Liquid Soap from Castor Oil and VCO at 75 °C

Table 1. The Effect of Type and Volume of Anti-bacterial Ingredients (Tannins and Lemongrass Oil) on the Diameter of the *Staphylococcus aureus* Bacterial Inhibition Zone in Liquid Soap from Castor Oil and VCO at 75 °C

Tannin Sample (mL)	Inhibition Zone (mm)	Lemongrass Sample (mL)	Inhibition Zone (mm)
2	22.5	2	30
2.5	24	2.5	30.5
3	25	3	44.5
3.5	33.5	3.5	45

4 Conclusion

The best conditions of the resulting liquid soap were achieved with the use of 4 mL tannins as anti-bacterial ingredients, producing soap with the following specifications: pH of 9.33; free alkali content of 0.0102%; specific gravity of 1.059; and the diameter of the bacterial inhibition zone of 35 mm. Whereas for the soap with active ingredient of 4 mL of lemongrass essential oil produced a pH of 9.39; free alkali content of 0.0163%; specific gravity of 1.071; and the diameter of the inhibition zone of 46.5 mm. The addition of the acti-bacterial ingredient of lemongrass essential oil produced a preferred liquid soap because it has a fresh scent of lemongrass leaves, thicker, has a lot of foam, more comfortable to use, and has a longer lasting scent. Liquid soap made from castor oil and VCO with the addition of anti-bacterial ingredients such as sorghum tannins and lemongrass essential oil are in accordance with SNI 06–4085-1996.

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