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Optimization of Antiseptic Paper Soap through Varying NaOH Concentration: Combination of Cooking Oil, Citronella Oil, and Aloe Vera

Optimasi Sabun Kertas Antiseptik melalui Variasi Konsentrasi NaOH: Kombinasi Minyak Goreng, Minyak Serai Wangi, dan Lidah Buaya

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Abstract

Antiseptic paper soap is convenient because it is flexible, safe for the skin, easily foams, and relatively affordable. Measuring the ratio between the concentrations of NaOH, cooking oil, citronella oil, and aloe vera additives is needed to improve the quality of antiseptic paper soap. Testing the saponification rate, density, pH, water content, fatty acid (FA) level, and free alkali content is critical to determine the characteristics of antiseptic paper soap so that it meets the standards for solid bath soap according to SNI 3532-2021 which is closest to the characteristics of paper soap because SNI for paper soap is not yet available. The weight ratio of citronella oil to cooking oil used is 1:1, 1:2, and 1:3. The NaOH concentrations used were 30%, 40%, and 50% w/v. The natural additives used are 0%, 5%, and up to 10% of the total mass. The research results showed that saponification value of the antiseptic paper soap produced was 197.724 milligrams KOH/gram up to 206.138 milligrams KOH/gram, the pH of the antiseptic paper soap was 9.1-10.6, the water content value was 10.940%-23.863%, the alkali content value free is 0.044%-0.104%, total fatty acid (FA) content is 29.688%-45.734%. The best antiseptic paper soap is produced using 30% w/v NaOH with a weight ratio of citronella oil to cooking oil used of 1:1 and natural additives (aloe vera) 5% of the total mass.
Keywords: aloe vera, antiseptic, citronella oil, cooking oil, paper soap

Abstrak

Sabun kertas antiseptik adalah sabun yang sangat praktis karena fleksibel, aman untuk kulit, mudah berbusa, dan harganya relatif terjangkau. Pengukuran rasio antara konsentrasi NaOH, minyak goreng, minyak serai wangi, dan aditif lidah buaya perlu dilakukan untuk meningkatkan kualitas sabun kertas antiseptik. Pengujian laju penyabunan, densitas, pH, kadar air, tingkat asam lemak (FA), dan kadar alkali bebas sangat penting untuk menentukan karakteristik sabun kertas antiseptik agar memenuhi standar sabun mandi padat sesuai SNI 3532-2021 yang paling mendekati karakteristik sabun kertas karena SNI untuk sabun kertas belum tersedia. Rasio berat minyak serai wangi terhadap minyak goreng yang digunakan adalah 1:1, 1:2, dan 1:3. Konsentrasi NaOH yang digunakan adalah 30%, 40%, dan 50% b/v. Bahan tambahan alami yang digunakan adalah 0%, 5%, hingga 10% dari massa total. Hasil penelitian menunjukkan bahwa bilangan penyabunan sabun kertas antiseptik yang dihasilkan adalah 197,724 miligram KOH/gram hingga 206,138 miligram KOH/gram, pH sabun kertas antiseptik adalah 9,1-10,6, nilai kadar air adalah 10,940%-23,863%, nilai kadar alkali bebas adalah 0,044%-0,104%, total kandungan asam lemak (FA) adalah 29,688%-45,734%. Sabun kertas antiseptik terbaik dihasilkan dengan menggunakan 30% b/v NaOH dengan rasio berat minyak serai wangi terhadap minyak goreng yang digunakan adalah 1:1 dan bahan tambahan alami (aloe vera) 5% dari total massa.
***Kata kunci**: antiseptik, lidah buaya, minyak goreng, minyak serai wangi, sabun kertas*

INTRODUCTION

Soap is currently produced in various shapes and unique packaging to meet consumer needs. One of the innovative soap products that is increasingly in demand is paper soap. This soap comes in thin sheets that resemble paper, even though the material it is made from does not contain paper. Paper soap has an attractive, luxurious, and classy appearance, so it has added value compared to other soaps (Jalaluddin et al., 2018). People in the current technological era want everything practical, including the soap they use. Paper soap is one of the soap industry innovations that fulfills people's desires. Paper soap is shaped as thin as paper, dissolves easily in water, and produces good foam, making it convenient to carry and suitable for outdoor activities (Marpaung et al., 2019).

Cooking oil and essential oils are components of antiseptic paper soap. The fatty acids in cooking oil play an essential role as fundamental elements in the soap production process. Fatty acids provide softness, dissolve easily in water, and are effective cleaners. Essential oils are used in antiseptic paper soap because of their pleasant aroma, relaxing effect, natural coloring (Djoru & Neonufa, 2023), and antiseptic (Manus et al., 2016), which improve the quality of paper soap. Essential oils are produced through secondary metabolic pathways in plants. This oil is known for its high volatility at room temperature, attractive aroma, and similarity to mineral oil. An example of an important essential oil is citronella oil. Citronella is a plant with many aromatic nutrients that can be used for health. Citronella contains various sources of essential vitamins, including vitamin A, vitamin B1 (thiamin), vitamin B2 (riboflavin), vitamin B3 (niacin), vitamin B5 (pantothenic acid), vitamin B6, folate, and vitamin C. Citronella also contains several essential minerals, such as potassium, calcium, magnesium, phosphorus, manganese, copper, zinc and iron which are needed for body health. Citronella can be classified as a flavonoid antioxidant and phenolic compound with medicinal properties. Citronella can also be used as an antifungal and antimicrobial agent because its main compound is lemonal or citral (Jalaluddin et al., 2018).

Another component used in the production of antiseptic paper soap is NaOH. NaOH facilitates the saponification process, which causes the oil or fat mixture to react quickly and form soap. The reaction time is directly proportional to the amount of oil saponified (Arbel, 2021). The correct ratio of NaOH concentration to oil will affect the quality of the soap produced. The addition of time will not affect the amount of saponified oil if the oil mixture reaction has reached an equilibrium state. Adding more oil than required ensures that the soap formed does not have an excessive free alkali value (Wibowo et al., 2021; Sukapiring et al., 2022).

The primary purpose of antiseptic paper soap is as a cleaner. From a marketing perspective, this is attractive only if accompanied by more specific benefits. Therefore, active chemicals that can provide multiple benefits are needed in antiseptic paper soap as a cleaning agent and medicine carrier for skin affected by diseases caused by free radicals, bacteria, and microbial infections. Aloe vera is a natural ingredient with antimicrobial characteristics. Aloe vera can also soften and moisturize the skin because its lignin or cellulose content can penetrate and absorb into the skin and hold body fluids out of the skin surface so that it effectively prevents the skin from drying out (Verawaty et al., 2020).

This research aims to make antiseptic paper soap from a mixture of cooking oil and citronella oil with aloe vera addition and determine the effect of cooking oil and citronella oil weight ratio on the saponification value, oil specific gravity, and NaOH concentration to meet Indonesian National Standard (SNI) 3532-2021 of solid bath soap. The SNI that regulates paper soap is not yet available, so SNI 3532-2021 is used because solid bath soap characteristics are closest to those of paper soap. This research also aims to determine the effect of aloe vera concentration on pH, water content, free alkali content, and total fatty acid (FA) of antiseptic paper soap.

METHODS

Ingredients and Apparatus

The ingredients used in antiseptic paper soap production are Bimoli brand cooking oil, citronella oil, and aloe vera. The cooking oil used in this research is palm oil. Citronella oil is obtained from the distillation of farmers in Central Aceh, Indonesia, and the quality is under SNI 3953-2019 Essential Oils of Citronella. The aloe vera used in this research came from plants cultivated for six months. Other ingredients used are NaOH (30%, 40%, and 50%), ethanol 96%, glycerin, Coco-DEA, NaCl, citric acid, stearic acid, H_2SO_4, HCl, KOH, Potassium Permanganate (PP), phenolphthalein, hexane solution, methyl orange indicator, sugar (sucrose), distilled water, and pH paper from Merck.

Apparatus used are beaker, measuring cylinder, magnetic stirrer, hot plate (HRDIK), spatula, two-neck flask, thermometer, digital scale (Remax RT-S1), Erlenmeyer, pH meter, pycnometer, oven

(Memmert), condenser (Aark), burettes, molds, petri dishes, porcelain crucible, funnel glass, separatory funnels, and volumetric flasks. This research was conducted using laboratory-scale experimental methods. The research procedure for making antiseptic paper soap is shown in Figure 1.

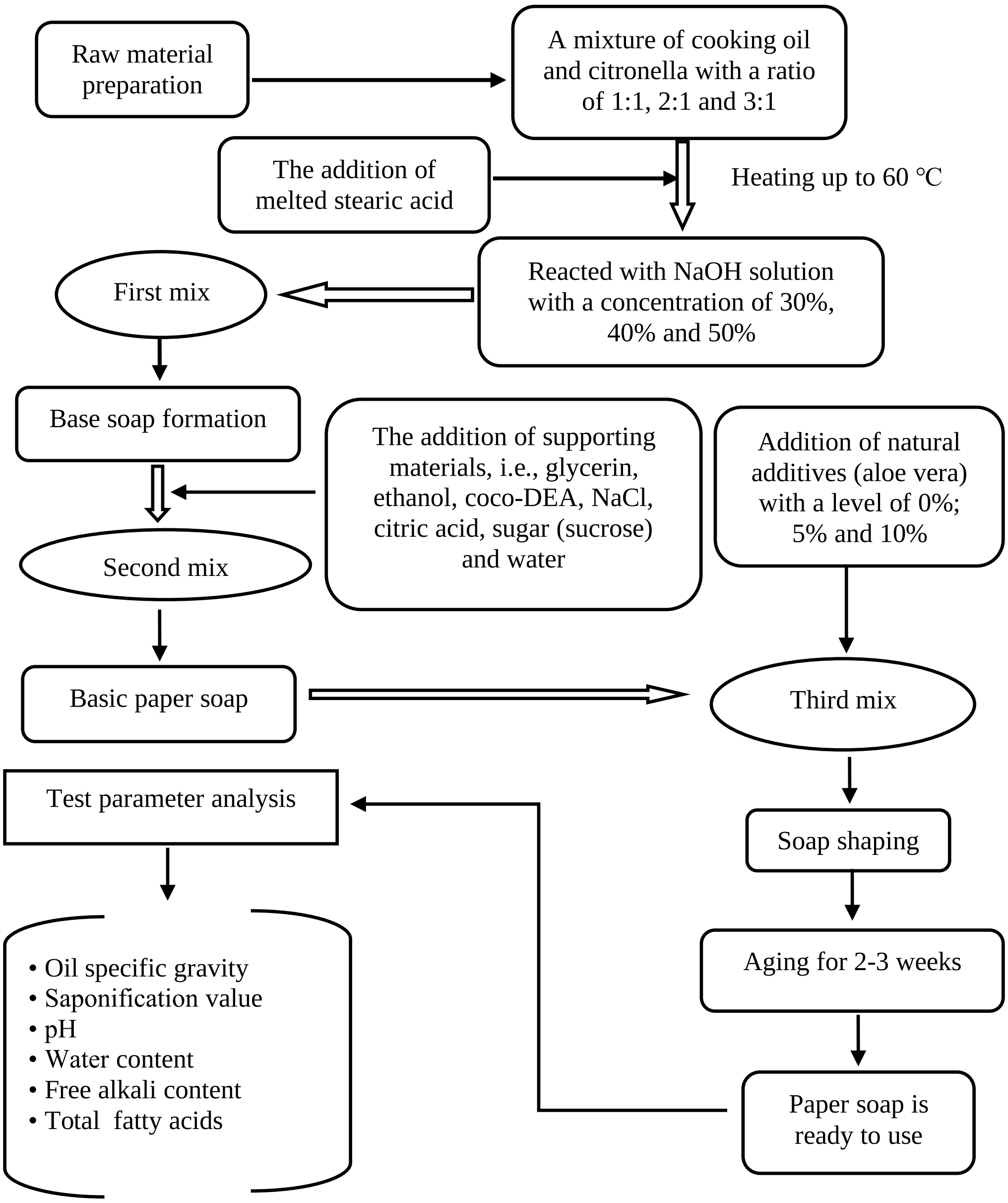

Figure 1. Research Procedure for Antiseptic Paper Soap Production

Antiseptic Paper Soap Production

Aloe vera, a natural additional ingredient in antiseptic paper soap production, is prepared first by grinding 100 grams of peeled aloe vera pieces using a blender. Then, it was sterilized by heating it at a temperature of 45 °C and then cooled. The cooled aloe vera was then added with 5 grams of citric acid to stabilize it (Handayani et al., 2020; Handayani et al., 2021).

Basic soap is made by reacting a mixture of cooking oil and citronella oil with NaOH or alkali. The ratio of citronella oil to cooking oil is 1:1, 1:2, and 1:3. The citronella oil used in this study was 20 grams. The mixture of cooking oil and citronella oil is heated to a temperature of 60 °C. 8 grams of stearic acid was added and stirred until homogeneous. NaOH is then added to the homogeneous mixture to form a solid soap. The initial concentrations of NaOH used before mixing were 30%, 40%, and 50%. Ethanol 96% 15 grams, glycerin 13 grams, Coco-DEA 3 grams, sugar (sucrose) 12 grams, NaCl 0.45 grams, citric acid 3 grams, and distilled water 250 mL are added to make the basic soap. Aloe vera was added with varying concentrations of 0%, 5% and 10%. Mixing was carried out at 60 °C to avoid color changes. The antiseptic paper soap mixture is directly shaped with a size of 2 cm x 2 cm and a thickness of 3 mm. The antiseptic paper soap is stored for 3–4 weeks to complete the saponification process. The temperature during the saponification process should be maintained at 60 °C -70 °C with constant tossing.

Analysis of Antiseptic Paper Soap

The antiseptic paper soap quality test was performed to determine the conformity of the antiseptic paper soap quality with the solid bath soap quality standards in SNI 3532-2021. This standard is used because the characteristics of solid bath soap are close to those of paper soap. The SNI for paper soap quality standards is not yet available. Antiseptic paper soap is analyzed qualitatively with laboratory tests, including oil-specific gravity, saponification value, water content, total fatty acids, free alkali content, and pH.

Oil Specific Gravity

The analysis of oil specific gravity is needed to determine the proportion of oil needed so that the quality of the antiseptic paper soap meets the standard. The specific gravity of oil is greatly influenced by the saturation level of its fatty acid components. A high specific gravity of oil indicates a high level of saturated fatty acid component in the oil (Latumakulita et al., 2023). Soap will become more solid if the amount of saturated fatty acids in the soap increases (Andriani et al., 2021). This condition will make it challenging to form aseptic paper soap. If m1 is empty pycnometer weight, m2 is pycnometer weight plus water mass, m3 is pycnometer weight plus oil mass, and the specific gravity of water (standard solution) is ρ, then the specific gravity of oil (ρ oil) can be calculated using the following equation (Gusviputri et al., 2013):

$$\rho \text{ Oil} = \frac{m_3 - m_1}{m_2 - m_1} \text{ x } \rho \text{ Water} \quad (1)$$

Saponification Value

Saponification value analysis is needed in antiseptic paper soap production to monitor the chemical reaction efficiency between oil and alkali (NaOH). The saponification value measures the amount of alkali needed to convert oil into soap (Gusviputri et al., 2013): This analysis was performed by weighing a 20 gram sample of a cooking oil and citronella oil mixture. 25 mL of 0.5 N KOH was added to the oil and then put into a two-neck flask connected to a condenser. The flask is heated on a water heater while stirring for 1 hour. The solution is then put into an Erlenmeyer. Two drops of PP indicator are added and titrated with 0.5 N HCl until the color is no longer red. The saponification number can be determined using the following equation (Gusviputri et al., 2013):

$$\text{Saponification Value} = \frac{\text{V HCl x N HCl x MW KOH}}{\text{Sample Mass}} \quad (2)$$

pH

pH analysis was performed to control the acidity level during the saponification reaction. Antiseptic paper soap with a pH suitable for human skin will be gentler and not cause irritation (Salsabila & Aini, 2023). This analysis was performed by weighing 1 gram of antiseptic paper soap, dissolving it in 10 mL of distilled water at pH 7, and stirring it in a glass beaker. The pH value of antiseptic paper soap can be seen from the pH meter dipped in the glass beaker.

Water Content

Water content analysis is performed to control the water content of antiseptic paper soap. Antiseptic paper soap with too high water content easily breaks and melts (Khulafaurrasidin, 2018). Water content was analyzed by weighing a 5 gram sample of antiseptic paper soap and then heating it in an oven at 105 °C on a petri dish until the weight was constant. Water content is calculated by looking at the difference in weight before and after drying. Water content can be calculated using the following equation (Khulafaurrasidin, 2018):

$$\text{Water Content (\%)} = \frac{\text{(Soap mass + petri dish after drying)-petri dish mass}}{\text{Soap mass}} \text{ x } 100\% \quad (3)$$

Free Alkali Content

Free alkali content analysis was carried out because the reaction in antiseptic paper soap production does not always run perfectly. The analysis of free alkali content aims to determine the alkali content that does not react or is saponified with fatty acids (Sukeksi et al., 2018). Free alkali that exceeds the standard value for solid bath soap set by SNI 3532-2021 can cause skin irritation and dry skin. The ratio of oil to alkali must be correct so that all the alkali reacts with the fatty acids (Muis, 2015). This analysis was performed by weighing a 10 gram sample of antiseptic paper soap, placing it in a 250 mL Erlenmeyer, and adding 25 mL of 96% ethanol. The mixture was stirred until dissolved, and three drops of PP solution were added. The solution was titrated with 0.1 N HCl until the red color disappeared. The volume of HCl used is recorded. The free alkali content can be calculated using the following equation:

$$\text{Free Alkali (\%)} = \frac{\text{V HCl x N HCl x MW NaOH}}{\text{Paper soap mass x 1000}} \text{x} 100\% \quad (5)$$

V: Volume; N: Normality; MW: Molecular Weight

Total Fatty Acids

Analysis of total fatty acids is to control the total fatty acid content in antiseptic paper soap. Total fatty acid content that exceeds the standard causes the soap to smell unpleasant and possibly harm the skin (Gusviputri et al., 2013). This analysis was performed by weighing a 10 gram sample of antiseptic paper soap, placing it in a 250 mL beaker, and dissolving it in 50 mL of water. Three drops of methyl orange indicator and 20% excess H2SO4 were added until the solution color turned red. The solution was put into a separating funnel and stirred for 15 minutes until two layers formed. The bottom layer (water) is removed, and then distilled water is added until it is not acidic, as indicated by the acidity test results using pH paper. Solvent and fatty acids are separated by distillation. The fatty acids were weighed, placed on a porcelain crucible, and heated in an oven at 105 °C for 1 hour. The weight is calculated after heating, and the porcelain crucible is empty. Total fatty acids can be calculated using the following equation (Gusviputri et al., 2013):

$$\text{Total Fatty Acid (\%)} = \frac{W_2\text{-}W_1}{\text{Paper soap mass}} \text{x} 100\% \quad (4)$$

W_2 = Mass of empty porcelain cruclible; W_1 = Mass of porcelain cruclible + fatty acid

RESULTS AND DISCUSSION

Oil Specific Gravity Analysis

Specific gravity is an essential parameter in the oil and chemicals analysis because it indicates the purity level. The results of this analysis can be used to understand the blended oil's physical and chemical characteristics and ensure its conformity with standards (Hidayati, 2012). Specific gravity analysis in this study was performed on a mixture of citronella oil and cooking oil. The relationship between the ratio of citronella oil to cooking oil and the oil specific gravity is shown in Figure 2.

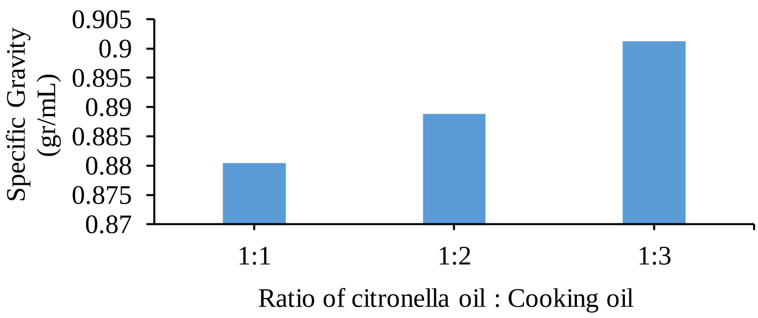

Figure 2. The Effect of Citronella Oil and Cooking Oil Ratio on the Specific Gravity of the Oil Used

The results of measuring oil specific gravity show that it is in the range of 0.8804 to 0.9012 grams per milliliter (g/mL). This result means that the oil specific gravity used in this research is below the standard specific gravity of Virgin Coconut Oil (VCO). SNI 7381:2022 Virgin Coconut Oil determines the specific gravity of VCO to be between 0.915 to 0.920 g/mL, while the specific gravity of citronella oil, according to SNI 3953-2019 Essential Oil of Citronella is between 0.880 to 0.902 g/mL. The addition of citronella oil to cooking oil reduced the oil specific gravity used in making antiseptic paper soap in this study. The oil specific gravity can increase if the oil is mixed with other ingredients with a heavier molecular weight (Hawkes, 2004).

Saponification Value Analysis

The oil quality used in soap production can be determined by calculating its saponification value. Oil quality decreases if the saponification rate is high (Supraptiah et al., 2022). Figure 3 shows the relationship between the ratio of citronella oil to cooking oil and the saponification value.

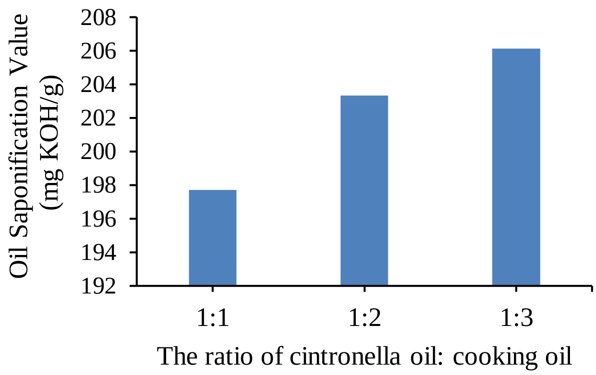

Figure 3. The Effect of Ratio Citronella Oil to Cooking Oil on Saponification Value

The oil saponification value is the quantity of potassium hydroxide (KOH) required to neutralize the free fatty acids in 1 gram of oil or fat. The ratio of citronella oil to cooking oil can affect the saponification rate. Figure 1 shows that the saponification number is 197.724 to 206.138 milligrams KOH/gram. SNI 7431:2015 states that the quality standard for pure vegetable oil is 180–265 milligrams KOH/gram. Hence, the saponification value in all ratio variations of citronella oil to cooking oil in this study meets SNI 7431:2015.

According to Herlina & Ginting (2002), the saponification value shows the total molecular weight of oil composed of short carbon chain fatty acids. The saponification value will be high if the molecular weight is low. A more significant proportion of cooking oil in a mixture of citronella oil and cooking oil can also increase the saponification rate (Mena et al., 2020). The highest saponification value in this study was obtained at a ratio of citronella oil to cooking oil of 1:3. Meanwhile, the lowest saponification value was obtained at a ratio of citronella oil to cooking oil of 1:1.

The saponification degree affects the NaOH level required in the saponification reaction. If the saponification degree is high, more NaOH is needed to neutralize free fatty acids in 1 gram of oil or fat. Less NaOH is needed to make antiseptic paper soap with a ratio of citronella oil to cooking oil of 1:1 than NaOH needed to make antiseptic paper soap with a ratio of citronella oil to cooking oil of 1:3. This is related to the stoichiometric saponification reaction as shown in Figure 4.

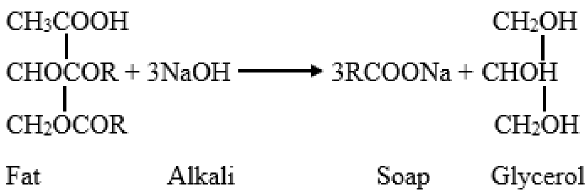

Figure 4. The Saponification Reaction between Oil (Fat) and NaOH (Alkali) for Soap Production

The saponification reaction will ideally occur based on the fat (oil) and alkali content used. In soap production, oils with high saponification value require more NaOH. A NaOH concentration that exceeds 24.39% can cause damage to the oil in soap production because the oil can experience excessive hydrolysis and produce soap that is too alkaline, smells, and breaks easily (Muis, 2015). The addition of NaOH concentration in soap production causes an increase in free alkali levels, which can quickly absorb skin moisture and trigger skin irritation due to the hygroscopic nature of NaOH (Dewi & Setyawan, 2022). The increase in free alkali levels is because NaOH does not entirely react with triglycerides (Agustin & Hendrawati, 2022).

pH

pH is a chemical parameter to determine the acidity of soap. The high pH value of antiseptic paper soap generally causes skin irritation. The relationship between NaOH concentration, the ratio of citronella oil to cooking oil, and the concentration of natural additives (Aloe vera) on the pH level of antiseptic paper soap can be seen in Figure 5. The pH analysis results show that the antiseptic paper soap pH is between 9.1 and 10.6. SNI 3532-2021 stipulates that the pH of solid bath soap is between 6 and 11. This result means that the pH of antiseptic paper soap at all variations in NaOH concentration, the ratio of citronella oil to cooking oil, and the concentration of natural additives in this study have met the standard for solid bath soap according to SNI 3532-2021.

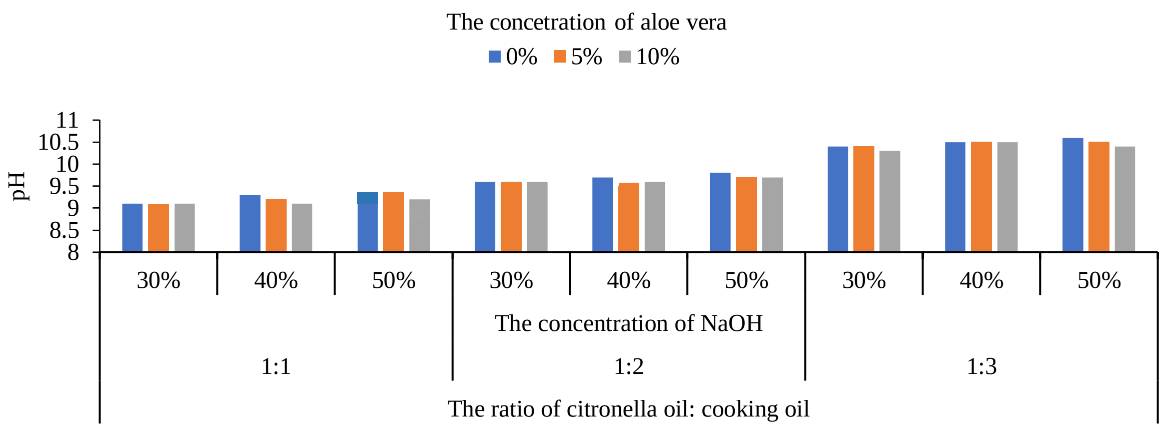

Figure 5. The Effects between NaOH Concentration, Ratio of Citronella Oil to Cooking Oil, and Concentration of Natural Additives (Aloe Vera) on the pH Level of Antiseptic Paper Soap

The concentration of NaOH, the ratio of citronella oil to cooking oil, and the concentration of natural additives affect the pH of antiseptic paper soap. The citric acid compound content in aloe vera can reduce the pH of antiseptic paper soap and can neutralize a small portion of NaOH (Sari et al., 2010). Aloe vera can also improve the soap quality. The antiseptic paper soap pH will be lower if the aloe vera concentration is high. Adding the concentration of NaOH, a strong alkaline, will also increase the pH of antiseptic paper soap. A smaller ratio of citronella oil to cooking oil requires more NaOH than the other. This result is because the pH of antiseptic paper soap with this ratio tends to be higher. Some commercial soap products have a pH of around 7 (neutral), so they are gentler on human skin and very safe for skin health. Some soap products also have a pH of around five because they are still considered safe for normal skin health (Mena et al., 2020; Supraptiah et al., 2022). A pH level that is too low or too high can impact skin health, triggering skin irritation, itching, peeling skin, and making skin dry easily (Aldiana & Nugraha, 2021).

Water Content Analysis

The maximum water content for solid soap based on SNI 3532-2021 Solid Bath Soap is 23%. The water content of solid soap can affect the soap's hardness. Too much water content can cause the soap to shrink easily and be less comfortable to use. According to Setiawan & Lilis (2018), excessive water content in soap can cause its weight to shrink if it is left in the open air without packaging because of water evaporation. The effect of NaOH concentration, the ratio of citronella oil to cooking oil, and the natural additives (Aloe vera) concentration on the water content of antiseptic paper soap can be seen in Figure 6.

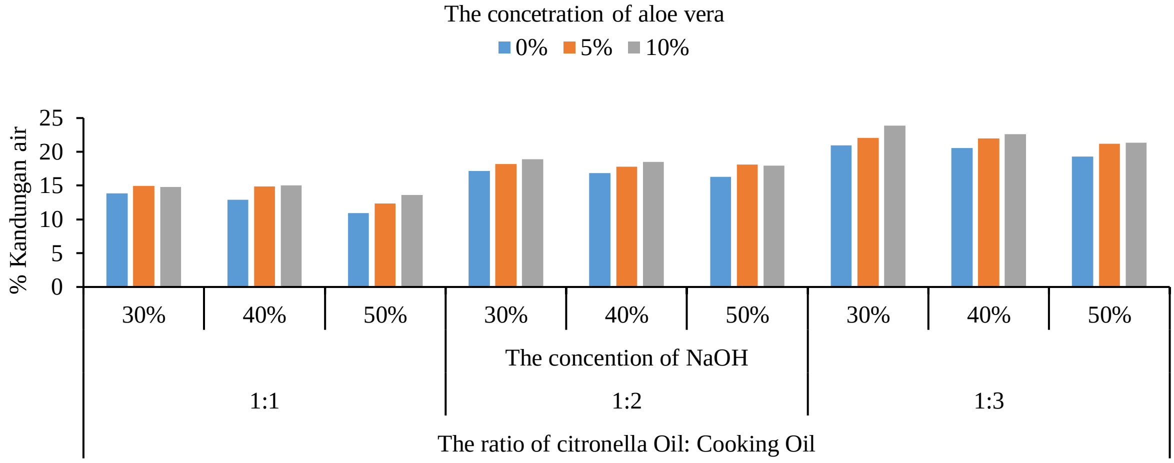

Figure 6. The Effect between NaOH Concentration, Ratio of Citronella Oil to Cooking Oil, and Concentration of Natural Additives (Aloe vera) on the Water Content of Antiseptic Paper Soap

Figure 6 shows that the water content of antiseptic paper soap is between 10.940% to 23.863%. SNI 3532-2021 stipulates that solid bath soap's maximum allowable water content is 23%. Therefore, the water content of antiseptic paper soap at all variations in NaOH concentration, the ratio of citronella oil to cooking oil, and the concentration of natural additives in this study meet the requirements for solid bath soap whose characteristics are similar to antiseptic paper soap.

Increasing the ratio of citronella oil to cooking oil and increasing the concentration of natural additives (Aloe vera) can increase the water content of antiseptic paper soap. Aloe vera contains saponin compounds, which can be hydrolyzed to produce glycones (sugar) that are hygroscopic (can absorb water), so the addition of Aloe vera can increase the water content in antiseptic paper soap (Widyasanti et al., 2018). Aloe vera gel is also dominated by water, affecting the water content of antiseptic paper soap. The water content at a high NaOH concentration (50%) is less than the water content at a lower NaOH concentration (30-40%), so the water content of antiseptic paper soap will be lower if the NaOH concentration is high (Silsia et al., 2017).

Free Alkali Content Analysis

The effect of NaOH concentration, the ratio of citronella oil to cooking oil, and the concentration of natural additives (Aloe vera) on the alkali content of antiseptic paper soap can be seen in Figure 7. Figure 7 shows that the free alkali content of antiseptic paper soap is between 0.044%-0.104%. SNI 3532-2021 Solid Bath Soap sets the maximum limit for the free alkali content in solid soap to be 0.1%. Therefore, the free alkali content of antiseptic paper soap in all variations of NaOH concentration, the ratio of citronella oil to cooking oil, and the concentration of natural additives in this study have met the SNI 3532-2021 Solid Bath Soap standard.

The highest free alkali content is found in antiseptic paper soap with a ratio of citronella oil to cooking oil of 1:3, NaOH concentration of 50%, and no natural additives. The lowest free alkali content is found in antiseptic paper soap with a ratio of citronella oil to cooking oil of 1:1, NaOH concentration of 30%, and natural additives of 10%. Widyasanti & Rohani (2017) explained that alkalinity increases if the pH value increases. The free alkali content in antiseptic paper soap also increases if the aloe vera concentration decreases. This result is because citric acid is added to mashed aloe vera as a stabilizer. Citric acid can reduce the free alkali content. Increasing the concentration of NaOH also increases the free alkali content in antiseptic paper soap because the saponification reaction is incomplete. This result is because the fatty acids in the ingredients for antiseptic paper soap production are insufficient to bind excess NaOH, so the free alkali content of antiseptic paper soap increases. NaOH is included in the strong alkali group, which can damage organic tissue easily and is corrosive (Silsia et al., 2017).

Antiseptic paper soap with a high saponification value (the ratio of citronella oil to cooking oil 1:3) has a low free alkali content. This result is because the antiseptic paper soap requires more NaOH to neutralize the free fatty acids so that only a little unreacted NaOH remains, and the free alkali content of the antiseptic paper soap is also low. The high free fatty acid content in antiseptic paper soap indicates that NaOH does not completely saponify free fatty acids (triglycerides). This condition can interfere with the soap's ability to emulsify or bind dirt.

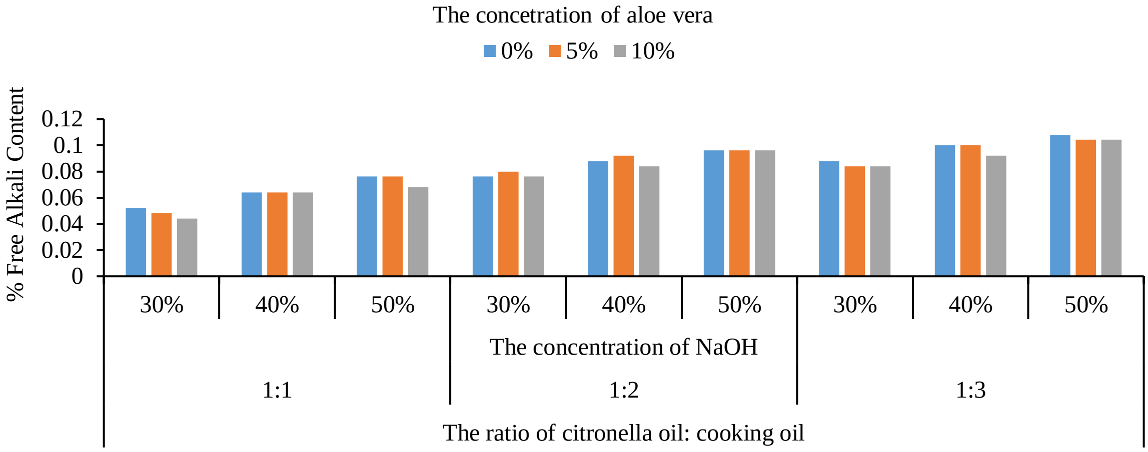

Figure 7. The Effect between NaOH Concentration, Ratio of Citronella Oil to Cooking Oil, and Concentration of Natural Additives (Aloe Vera) on the Alkali Content of Antiseptic Paper Soap

Total Fatty Acid Analysis

According to Awaluddin et al. (2022), total FA is the accumulation of all FA in antiseptic paper soap that has reacted with alkali or free FA plus neutral fat (neutral triglycerides) or unsaponifiable fat. FA plays a role in regulating the consistency of soap, making it difficult for soap to dissolve in water and influencing the characteristics of the antiseptic paper soap produced. The FA content also increases the efficiency of cleaning dirt (oil or fat) when using soap. According to Sari (2012), soap with a high total fatty acid content will produce a smooth, soft, and moisturizing texture. The FA contained in antiseptic paper soap comes from the acid content in vegetable oils and stearic acid. The quantity and type of FA can influence the characteristics of the soap produced (Ainiyah & Utami, 2020). Measurement of FA levels in antiseptic paper soap by breaking the bonds between FA and NaOH using strong acid. The relationship between NaOH concentration, the ratio of citronella oil to cooking oil, and the concentration of natural additives (Aloe vera) on the total FA content of antiseptic paper soap can be seen in Figure 8.

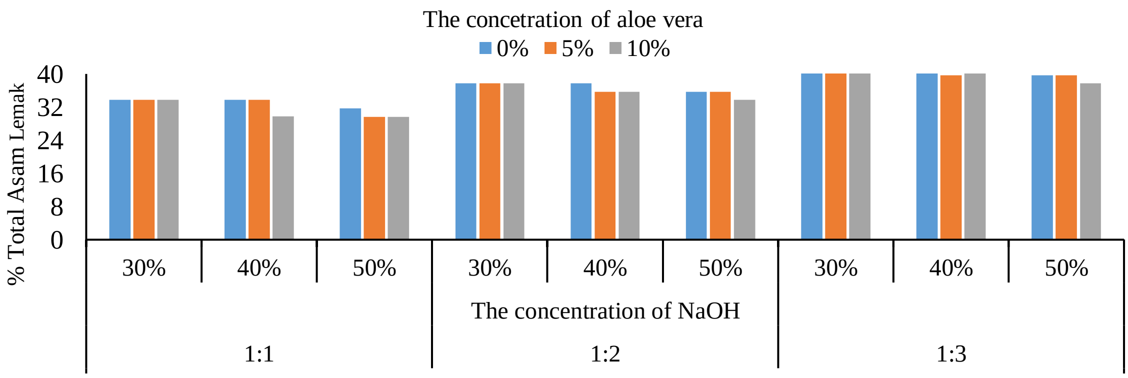

Figure 8. The Effect between NaOH Concentration, Ratio of Citronella Oil to Cooking Oil, and Concentration of Natural Additives (Aloe Vera) on Total FA Content of Antiseptic Paper Soap

Figure 8 shows that the total FA content of antiseptic paper soap is between 29.688% - 45.734%. SNI 3532-2021 sets the minimum limit for the total FA content allowed in solid soap to be 60%. Therefore, the total FA content of antiseptic paper soap at all variations in NaOH concentration, the ratio of citronella oil to cooking oil, and the concentration of natural additives in this study did not meet these requirements.

The highest total FA content was found in antiseptic paper soap with a ratio of citronella oil to cooking oil of 1:3, NaOH concentration of 30%, and no natural additives. The lowest total FA content was found in antiseptic paper soap with a ratio of citronella oil to cooking oil of 1:1, NaOH concentration of 50%, and natural additives of 10%. The decrease in the total FA value in this study was caused by using additional ingredients in the formulation of antiseptic paper soap, which can form a transparent structure. This result causes the FA content to be much lower than that of ordinary soap (Awaluddin et al., 2022). According to research conducted by Sari et al. (2010), the decrease in the total FA value of antiseptic paper soap was caused by additional ingredients used in soap production. Aloe vera contains active alkaloid compounds (organic compounds), which can cause the double bonds in the oil to be broken so that the amount of FA is reduced (Widyasanti & Rohani, 2017). The antiseptic FA content of paper soap comes from the stearic acid and vegetable oil used. Therefore, antiseptic paper soap with a ratio of citronella oil to cooking oil of 1:3 has a higher total FA content than antiseptic paper soap with a ratio of citronella oil to cooking oil of 1:1.

CONCLUSIONS

The concentration of NaOH, cooking oil, citronella oil, and the addition of aloe vera affect the quality of antiseptic paper soap. Increasing the concentration of NaOH in antiseptic paper soap production causes an increase in the saponification value but reduces the free alkali content. Higher NaOH concentrations increase the efficiency of the soaping process while reducing free alkali residues in antiseptic paper soap.

Reducing the ratio of citronella oil to cooking oil can increase the total fatty acids in soap while adding citronella oil tends to reduce the soap's pH value. The ratio of citronella oil to cooking oil is essential in determining antiseptic paper soap's fatty acid balance and acid-base properties.

The addition of aloe vera in antiseptic paper soap production reduces total fatty acids. The addition of aloe vera also tends to influence the water content of antiseptic paper soap in varying ways, depending on the aloe vera and NaOH concentration. Adding aloe vera can help improve the cleansing properties and gentleness of the soap.

Further research is needed to understand the influence of the cooking oil raw material type and the influence of concentration variations in the ingredients, such as aloe vera, on the quality and antiseptic effectiveness of paper soap so that it meets SNI requirements. Clinical and dermatological tests may also be performed to verify the soap's safety and effectiveness on various skin types. Market studies can be conducted regarding consumer preferences and potential product formula or packaging improvements.

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