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Research Paper

Production of Transparent Soap from Virgin Coconut Oil: Evaluation of Water and Free Alkali Contents

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ABSTRACT

The production of transparent soap involves a precise formulation and process to ensure clarity, skin-friendliness, and adherence to quality standards. This study focuses on the formulation, production, and quality analysis of transparent soap using Virgin Coconut Oil (VCO) as the primary fat source due to its high lauric acid content, which provides moisturizing and skin-smoothing benefits. The production process included the use of methanol, glycerin, ethanol, stearic acid, and a sucrose solution to enhance transparency. Two practical experiments were conducted. In the first, the soap partially solidified during the addition of dyes and fragrance due to delayed molding. In the second, premature hardening occurred due to the simultaneous addition of sodium hydroxide (NaOH) and ethanol, which led to unsuccessful soap formation. Despite these setbacks, a quality analysis of the resulting transparent soap was conducted to evaluate water content and free alkali levels, comparing them to the standards established by the National Standardization Council (SNI 06-3532-1994). The results showed that the soap had a water content of 0.33%, well below the maximum limit of 15%, indicating good solubility and firmness. The free alkali content in both trials was within acceptable limits, ensuring the soap is safe for skin use. These findings suggest that while process optimization is essential to prevent premature solidification, the formulation has the potential to produce high-quality transparent soap that meets national standards. Further refinement of the production technique is recommended to ensure consistent results in future applications.

Keywords: transparent soap, virgin coconut oil, lauric acid, water content, free alkali content

INTRODUCTION

Transparent soap, also known as glycerin soap, is a type of bath soap that produces foam that is gentler on the skin. Its appearance is clearer and more sparkling compared to other types of soap, such as regular opaque bath soap. Transparent soap has a high level of clarity and emits deeply diffused light through small particles, allowing objects placed behind the soap to be visible up to a depth of 6 cm [1].

Transparent soap is one of the most popular products in the chemical industry and is in high demand by the people of Indonesia. However, to meet this demand, the country still relies heavily on imports. Transparent soap is often imported from countries such as Hong Kong, Japan, Taiwan, Singapore, and Malaysia [2, 3].

Virgin Coconut Oil (VCO) contains very high levels of lauric acid, which is essential in the process of making transparent soap. Lauric acid functions to soften and moisturize the skin, enhancing the soap's cosmetic benefits. Soap is generally produced through a chemical reaction called saponification, in which a base such as sodium hydroxide or potassium hydroxide reacts with fatty acids from vegetable oils or animal fats [4, 5]. The resulting soap molecules consist of a carbon chain, hydrogen, and oxygen, arranged into two functional groups: a hydrophilic "head" (carboxyl group) that binds with water and a hydrophobic "tail" (hydrocarbon chain) that binds with dirt and oil [6, 7].

Unlike opaque soap, which is typically bar-shaped and non-transparent, glycerin soap has a more appealing appearance due to its clarity. The transparency adds to its marketability and is especially preferred for cosmetic and aesthetic purposes [8].

The process of making transparent soap has been known for centuries. One of the earliest and most famous examples is Pears Transparent Soap, which has been sold in England since 1789. This soap earned 25 top honors at exhibitions held in 1851 and 1935 for its quality and innovation [9, 10].

Transparent soap can be produced in several different ways. One of the oldest techniques involves dissolving the soap in alcohol under gentle heating to form a clear solution, which is then colored and scented. The final appearance of the soap depends largely on the quality of the starting materials; if inferior ingredients are used, the soap may appear yellow rather than clear [11].

In recent years, there has been increased interest in using natural oils such as VCO in transparent soap formulations due to their skin-friendly properties and renewable nature. VCO-based transparent soap is not only biodegradable but also rich in antimicrobial agents, making it a preferred alternative for eco-conscious consumers. Researchers continue to explore the ideal ratios and conditions for optimizing the transparency, hardness, and moisturizing qualities of soap made from VCO and other natural oils [9, 10].

Moreover, the development of transparent soap has extended beyond just cosmetic appeal. Functional soaps with added benefits such as antibacterial, anti-aging, or herbal properties are now being produced using transparent soap bases. This trend reflects growing consumer awareness of skincare and the desire for products that offer both beauty and health benefits [11].

MATERIALS & METHODS

Production of Transparent Soap

- Weigh 50 grams of VCO into a reactor, then gradually add 20 grams of stearic acid while stirring at 70°C.
- Add 32 mL of 30% NaOH solution (preheated to 60°C) into the mixture of oil and stearic acid while stirring continuously for 30 minutes. Maintain the temperature at 70°C.
- Add 33 mL of ethanol and stir the mixture for another 5 minutes.
- Add a solution of 17 grams of sucrose dissolved in 10 mL of water, followed by the addition of 17 mL of glycerin. Stir the mixture until homogeneous, then stop heating.
- Add coloring and fragrance (as desired) into the reactor while stirring evenly.
- Pour the mixture into a soap mold. After three weeks, the soap is ready to be tested for quality.

Analysis of Free Alkali Content

- Weigh 5 grams of transparent soap into an Erlenmeyer flask.
- Add 50 mL of hot neutral ethanol and allow it to cool.
- Once the sample has cooled, add 2 drops of phenolphthalein (PP) indicator and titrate with 0.1 N HCl solution until the light pink color disappears.
- Calculate the alkali content of the soap based on the volume of HCl used.

$$\text{Alkali content (\%)} = \frac{\text{mL HCl x N NaOH x molar mass of NaOH}}{\text{sample mass x 1000}} \text{ x } 100\%$$

Analysis of Water Content

- Weigh 5 grams of transparent soap into a porcelain drying dish (steamer cup).
- Heat the dish in an oven at 105°C for 15 minutes.
- Remove the dish from the oven and cool it in a desiccator until it reaches room temperature.
- Weigh the dried soap to determine the water content by calculating the weight loss

$$\text{Water content (\%)} = \frac{\text{mass of wet sample} - \text{mass of dry sample}}{\text{mass of wet sample}} \times 100\%$$

RESULT & DISCUSSION

Discussion of Transparent Soap Production

The variation in transparent soap formulation lies primarily in the selection and ratio of raw materials, including the type of alcohol used (e.g., methanol or ethanol), the amount of glycerin, and the ratio between sucrose and water used to prepare the sucrose solution. In our practical soap-making session, we used Virgin Coconut Oil (VCO) as the main raw material due to its high lauric acid content. Lauric acid plays a critical role in softening and moisturizing the skin, making VCO an excellent choice for transparent soap production [11].

We conducted two experiments to produce transparent soap. In the first experiment, the initial stages of soap formation were successful. However, delays during the addition of colorant and fragrance caused the soap mixture to begin hardening inside the heated beaker. This delay made it difficult to transfer the mixture into the mold in time, resulting in a failed attempt. In the second experiment, failure occurred during the addition of sodium hydroxide (NaOH) and ethanol. These two components were added simultaneously after the stearic acid had already dissolved in the VCO. Because NaOH is a strong base and highly hygroscopic, it caused premature solidification during stirring, resulting in soap that could not fully develop its transparent structure [12].

Ethanol, a volatile organic compound with the chemical formula C_2H_5OH, is commonly used in transparent soap making due to its ability to dissolve in both water and fats. It acts as a solvent that helps achieve the soap's clarity [13]. However, if not added properly or in the correct sequence, ethanol can evaporate too quickly or disrupt the emulsification process, which may compromise the transparency of the soap. Moreover, timing and temperature play a significant role in ensuring that each component integrates well with the others. The improper mixing technique in the second trial was a key factor that hindered successful saponification and transparency formation.

The addition of a sucrose solution is also a critical step in producing transparent soap. Sucrose aids in the development of crystalline structures within the soap matrix, contributing to its clarity and texture [14, 15]. When combined with glycerin and alcohol, sucrose enhances the formation of a translucent, glass-like structure. However, during our trials, the addition of sucrose and glycerin was made after the soap solution had already begun to solidify. This premature coagulation prevented the mixture from blending uniformly, affecting the final product's transparency and texture [15]. To achieve optimal clarity, it's essential to control the cooling rate and ensure all components are added at the right temperature and sequence.

Transparent soap production requires precision and attention to detail. The order of mixing, temperature control, and timing of ingredient addition are crucial to avoid soap hardening at the wrong stage. The learning experience from both failed trials highlighted the importance of procedural accuracy and provided insights into how small deviations can significantly impact the final product. Future improvements could involve better temperature monitoring, pre-warming molds to delay solidification, or using more controlled methods for adding sensitive ingredients like fragrance and colorants.

Discussion of Transparent Soap Quality Analysis

Table 1. Comparison of Transparent Soap Quality Analysis with SNI Standards

Parameter	SNI Standard	Experiment 1 Result	Experiment 2 Result	Remarks
Water Content (%)	≤ 15%	0.33%	0.33%	Meets standard; low water content is acceptable
Free Alkali (NaOH) (%)	≤ 0.10%	0.0424%	0.0352%	Meets standard; safe for skin
Color Change in Titration	Color change must occur (pH endpoint)	No color change observed	No color change observed	Indicates very low or 0% free alkali
Soap Texture	Firm, not sticky or brittle	Slightly hard due to delay	Softer but slightly coagulated	Affected by stirring and addition timing
Transparency	Clear (≥ 6 cm visible through soap)	Partially transparent	Less transparent	Impacted by early hardening and poor mixing

The analysis of transparent soap quality aims to evaluate whether the soap meets the Indonesian National Standard (SNI 06-3532-1994), established by the National Standardization Council in 1994. This includes key parameters such as water content and free alkali content, which are essential indicators of soap safety and usability [12].

Based on the results shown in the analysis table, the water content in the transparent soap samples was 0.33%, which is significantly lower than the maximum limit of 15% allowed by SNI. This suggests that the soap is within acceptable quality limits. Low water content generally improves the soap's hardness and shelf life, while excessive water can lead to a soft texture and quicker dissolution during use. Thus, the analyzed soap demonstrates good textural integrity and usage efficiency [11].

Regarding free alkali content, SNI standards specify a maximum of 0.1% NaOH. During our analysis, the titration test using HCl showed no color change, suggesting a free alkali value of 0. However, when assuming a light pink endpoint, the free alkali values were 0.0424% in the first experiment and 0.0352% in the second. These results fall within the SNI standard and indicate that the soap is safe for skin use. Maintaining a low free alkali level is essential, as high levels can cause skin irritation and damage [14].

CONCLUSION

The production of transparent soap involves careful selection and handling of raw materials such as Virgin Coconut Oil (VCO), glycerin, ethanol, and sucrose solution. VCO was chosen due to its high lauric acid content, which benefits the skin by moisturizing and smoothing it. In the practical experiments, both attempts at making transparent soap faced challenges. The first attempt failed due to delayed transfer of the mixture into the mold after adding dye and fragrance, causing premature hardening. In the second attempt, the simultaneous addition of NaOH and ethanol caused early solidification, as NaOH is a strong, reactive base and ethanol acts as a solvent. Missteps in the timing and method of mixing these components were key factors in the failure of both experiments.

In terms of quality analysis, the transparent soap produced met the required standards set by SNI 06-3532-1994. The measured water content was significantly below the 15% maximum limit, at just 0.33%, indicating good soap texture and solubility. Additionally, the free alkali content was found to be within acceptable limits in both experiments (0.0424% and 0.0352%), despite some challenges in determining the exact value through titration. The low free alkali content confirms that the soap is safe for skin use, as excessive alkali can cause irritation. Overall, while the practical process faced execution issues, the quality analysis shows that the final product has the potential to meet national standards with improved technique.

In conclusion, while the production process faced some practical challenges, the quality analysis indicates that the final product meets safety and performance standards. These findings emphasize the importance of refining the production process to consistently achieve transparency without compromising chemical quality. Future experiments should focus on refining mixing sequences, controlling the rate of cooling, and using precise equipment to ensure that transparent soap can be produced reliably and in accordance with established standards.

Declaration by Authors

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