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Identification of vegetable fat formulations on hardness, cleaning and conditioning of solid soap

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Abstract

This study aims to examine the effect of varying vegetable oil compositions (coconut, palm, and olive) on the physical and chemical qualities of solid soap, specifically in terms of hardness, cleansing ability, and moisture content. This study used a laboratory experiment with five soap formulas combining various vegetable oil compositions. The results showed that the formula with a combination of 60% coconut oil and 40% palm oil produced the soap with the highest hardness, while the formula with a combination of 60% coconut oil and 40% olive oil provided the best moisture content. The soap with a composition of 60% coconut oil and 40% palm oil also demonstrated better cleaning ability, thanks to the lauric acid content in coconut oil, which has antibacterial properties. This study recommends the use of a combination of coconut and palm oils to produce soap with the best quality in terms of hardness and cleansing ability, and coconut and olive oils for soap with greater skin moisturizing properties. It is hoped that this research will contribute to the development of the natural soap industry in Indonesia, reduce dependence on imported raw materials, and increase the competitiveness of natural soap products in the global market.

Keywords: Vegetable Fat; Solid Soap; Hardness; Clencing and Conditioning.

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INTRODUCTION

(Afriyanti et al., 2016; Farobie & Hartulistiyoso, 2022; Mukherjee & Sovacool, 2014) repots Indonesia, rich in natural resources, is a prominent player in the production of coconut and palm oil, two essential vegetable oils with vast potential for various industries, including soap manufacturing. Despite this abundance, Indonesia has yet to fully harness the value of these resources, particularly in

producing high-quality soap products. Solid soaps made from coconut and palm oils have demonstrated excellent properties, offering high-quality products that can help reduce the country's dependency on imported raw materials (Alouw & Wulandari, 2020; Nitbani et al., 2022). This presents a unique opportunity to explore the potential for increasing the value-added production of soap, enhancing both domestic consumption and international competitiveness.

Indonesia is one of the largest producers of coconuts globally (Alouw et al., 2025; Rethinam, 2018). The coconut, especially its oil, is a key ingredient in various consumer products, ranging from food and beverages to cosmetics and personal care items. Among its many benefits, coconut oil is particularly valued in soap production due to its high lauric acid content, which imparts antibacterial, anti-inflammatory, and cleansing properties. These properties make it an ideal choice for creating natural soaps that cater to a growing consumer demand for products with skin benefits. According to Nitbani et al. (2022) and Suryani et al. (2020), coconut oil-based soaps provide excellent cleansing abilities while being gentle on the skin, making them suitable for various skin types and conditions.

In addition to coconut oil, palm oil is another crucial raw material for soap production in Indonesia. As a major producer of palm oil, Indonesia benefits from the affordability and accessibility of palm oil, which contributes to the hardness and stability of soaps (Hidayat et al., 2018; Selladurai & Kathiresapillai, 2019). Palm oil soaps are known for their longevity, with a longer shelf life compared to soaps made from other oils. The inclusion of palm oil enhances the soap's ability to retain moisture and provides excellent skin-softening effects. These characteristics make palm oil an essential component in both bar and liquid soap formulations, helping to meet the growing demand for durable and effective personal care products.

Indonesia’s dependence on imported raw materials for the cosmetics and soap industries remains a significant challenge. According to Febijanto et al. (2023), a large portion of the raw materials used in soap production, especially in the cosmetics sector, is still imported due to limitations in domestic production. This reliance on foreign imports presents an opportunity for Indonesia to enhance its local industry by utilizing abundant domestic resources such as coconut and palm oils. By focusing on these locally sourced oils, the country can reduce its dependency on imports and increase its competitiveness in the global market, especially as consumers globally become more conscious about the environmental impact of their purchasing choices.

The global demand for natural, eco-friendly products is on the rise. As consumers shift towards sustainable and ethically produced goods, the soap industry is experiencing a significant transformation. A growing number of consumers are looking for products made from natural ingredients that are biodegradable and free from harmful chemicals (Gunawan et al., 2020). Soap products derived from coconut and palm oils, which are renewable and biodegradable, offer an attractive solution to meet this demand. These oils not only provide functional benefits in soap production but also contribute to the sustainability of the products, making them more appealing to environmentally conscious consumers.

Natural soaps made from coconut and palm oils have several advantages over synthetic alternatives. Coconut oil is known for its ability to produce a rich lather, enhancing the soap’s cleansing properties. Furthermore, the medium-chain fatty acids in coconut oil are biodegradable, which makes coconut oil-based soaps a more

environmentally friendly option compared to those made with synthetic detergents or harsh chemicals. The inclusion of palm oil in soap formulations contributes to the soap's hardness and durability, allowing for longer use while maintaining its cleaning efficacy. Additionally, palm oil-based soaps are excellent for moisturizing and softening the skin, making them suitable for daily use (Partida et al., 2007).

Natural soaps made from these oils are not only functional but also offer several skin benefits. As noted by Adigun et al. (2019) and Félix et al. (2017), coconut oil's high lauric acid content provides antibacterial and anti-inflammatory properties, helping to reduce skin irritation and promote overall skin health. Furthermore, the use of herbal extracts such as rosemary, lavender, and tea tree oil can further enhance the soap's skin benefits by providing antioxidant, anti-inflammatory, and antimicrobial properties (Adigun et al., 2019). The incorporation of such ingredients improves the quality of the soap and offers consumers additional skincare benefits, making them an attractive choice in the competitive global market.

The global market for natural soap is expanding rapidly as consumers become more concerned with the ingredients in the products they use and their environmental impact. According to Argyropoulou et al. (2013) and Chirani et al. (2021), consumers increasingly prefer products that are not only effective but also derived from natural and renewable ingredients. This growing preference for natural personal care products is driving the demand for vegetable oil-based soaps. In particular, natural soaps made with plant extracts and essential oils are gaining popularity due to their perceived health benefits, as well as their environmentally friendly and biodegradable nature.

Despite the benefits of natural soap, there are still challenges related to the use of vegetable oils in soap production. One of the key concerns is the variation in the physical and chemical properties of different vegetable oils and how they influence the final quality of the soap. While coconut and palm oils are known for their excellent qualities in soap production, there is limited research on how different fat compositions from various vegetable oils, such as olive oil or even local oils, affect soap hardness, moisture retention, and cleaning ability. This knowledge gap needs to be addressed to optimize soap formulations and ensure consistency in product quality. This research aims to address these gaps in knowledge by investigating how varying compositions of coconut oil, palm oil, and olive oil affect the physical and chemical properties of soap, particularly in terms of hardness, moisture retention, and cleaning efficacy. The key objectives of the study are: *Analyzing the Effect of Combining Coconut Oil, Palm Oil, and Olive Oil on Soap Hardness, Moisture, and Cleaning Ability*. The research will focus on how different proportions of these oils influence the soap's hardness, moisture retention, and cleaning ability. By experimenting with different formulations, the study will provide insights into how combining these oils can optimize soap performance while maintaining eco-friendly properties.

METHOD

This research is an experimental study carried out in a laboratory to assess how different compositions of vegetable oils affect the physical and chemical properties of solid soap. The research design involves experimenting with various formulations of soap that combine coconut oil, palm oil, and olive oil in different proportions. The soaps produced will undergo tests to evaluate their physical and chemical

characteristics, such as hardness, moisture, pH, and cleansing effectiveness. The goal of this experimental setup is to create an optimal natural soap formula by adjusting the vegetable oil composition. The results will be quantitatively analyzed, and statistical methods will be applied to understand the influence of each oil composition on the soap's quality.

The study utilizes samples of vegetable oils, specifically coconut oil, palm oil, and olive oil. There are three formulations based on these oils with different ratios: Palm Oil, Coconut Oil, Olive Oil (60%, 30%, 10%), Palm Oil, Coconut Oil, Olive Oil (40%, 30%, 30%), and Palm Oil, Coconut Oil, Olive Oil (60%, 40%, 0%). These oils were selected based on the abundant local availability in Indonesia, with coconut and palm oil being key ingredients in natural soap production. The primary characteristic of these oils lies in their distinct physical and chemical properties, which will influence the final soap's quality. The selection aims to explore the potential of utilizing local materials in crafting eco-friendly and high-quality natural soaps.

Instruments used for this research include a durometer to measure soap hardness, a moisture meter, a pH meter, and stain testing equipment. To ensure accuracy, the validity of these instruments is verified by comparing the measurements to established standards, and reliability is assessed by conducting repeated tests for consistency. The procedure begins with selecting and preparing the oils, followed by a cold saponification process. The oils are heated to 40-50°C, then mixed with a sodium hydroxide solution dissolved in water. This saponification process is carried out for several hours to ensure thorough reaction. Afterward, the soap is poured into molds and left to harden for 24 hours. The soap is then cut and left to air-dry for 4-6 weeks to complete the curing process. Tests are conducted on the soap after curing to evaluate its hardness, moisture, pH, cleaning ability, and skin-softening qualities.

The data from the hardness, moisture, pH, cleaning ability, and skin softness tests will be analyzed using statistical techniques, particularly analysis of variance (ANOVA). This analysis will help determine the significant impact of varying oil compositions on soap quality. Additionally, the results will be compared with the Indonesian National Standards (SNI) for solid soap to ensure that the soap meets the required quality criteria. This analysis will aid in identifying the optimal formulation of vegetable oils to produce high-quality natural soap that can compete in both local and international markets.

RESULTS AND DISCUSSION

The Effect of Oil Composition Variations on Soap Hardness

In this study, soap hardness testing results showed that a soap formula using 60% coconut oil and 40% palm oil produced higher hardness compared to other formulas. The formula with 60% coconut oil and 40% olive oil showed lower hardness, while the combination of palm oil and coconut oil produced a harder soap. This can be explained by the role of palm oil, which has stable and hard properties, contributing to soap hardness. Conversely, coconut oil with a higher lauric acid content provides softness, which can affect the overall hardness of the soap. As shown in Figure 1, soaps high in coconut oil tend to be softer, while those high in palm oil tend to be harder.

Figure 1. Yellow textured soap rich in palm oil, greenish white rich in coconut oil.

Palm oil contains more saturated fatty acids than coconut oil, which contribute to the stability and hardness of soap. Research by Selladurai & Kathiresapillai (2019) states that palm oil plays a significant role in imparting hardness to soap, while coconut oil provides softness and better foaming ability. This research supports the findings that the combination of these two oils plays a crucial role in achieving a balance between hardness and softness in soap. The results were confirmed by organoleptic testing and aided by the application of soapcal, as shown in Figure 2.

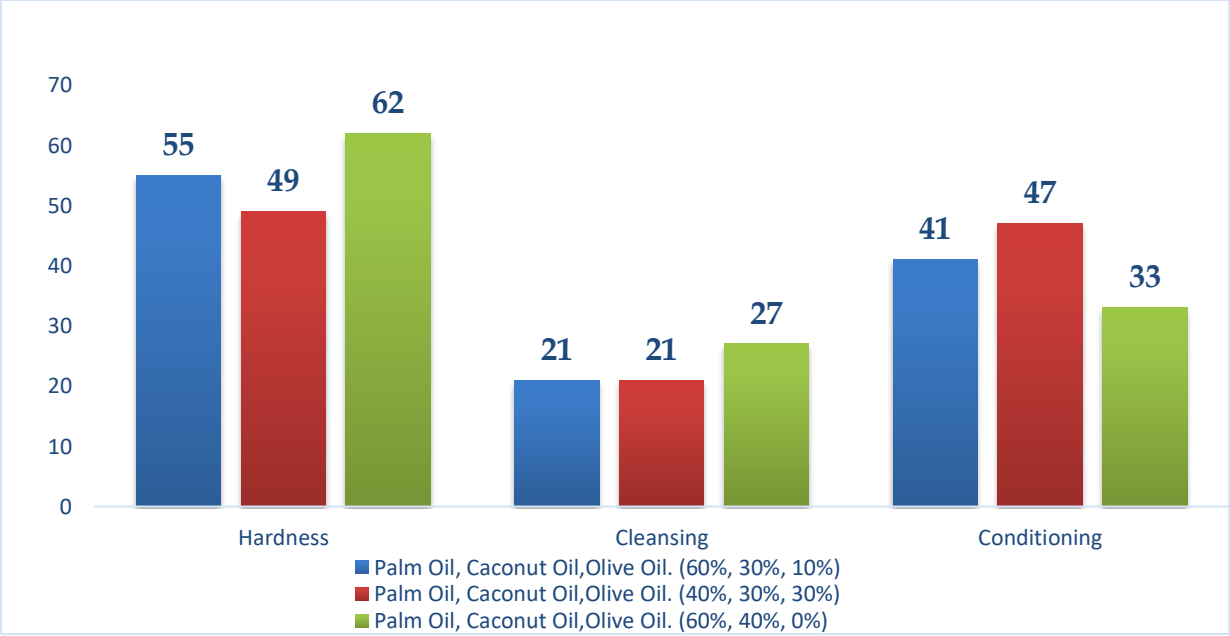

Figure 2. Relationship between Vegetable Oil Composition and Its Physical Properties.

Impact of Variations in Oil Composition on Cleaning Effectiveness

In terms of cleaning effectiveness, the soap formula containing 60% coconut oil and 40% palm oil outperformed the other formulas. Coconut oil is widely known for its antibacterial properties and superior cleansing abilities due to its high lauric acid content. This combination of oils is more effective in removing dirt and oils, especially stubborn stains. Lauric acid in coconut oil has strong antibacterial properties, which enhances its cleaning performance. Nitbani et al. (2022) explain that lauric acid has bactericidal qualities, thereby improving the soap's ability to remove germs and

impurities. These findings align with previous research that highlights the significant role of coconut oil in boosting the cleaning effectiveness of natural soaps.

Effect of Oil Composition Variations on Soap Moisture Retention (Conditioning)
Moisture testing results indicated that the soap formula containing 60% coconut oil and 40% olive oil showed the highest moisture retention. Coconut oil helps in maintaining skin hydration, while olive oil adds softness and moisture. This soap leaves the skin feeling soft and comfortable after use, making it more suitable for long-term application. Olive oil is recognized for its high content of unsaturated fatty acids, which aid in improving skin moisture. Research by Suryani et al. (2020) shows that olive oil helps preserve skin moisture and enhances skin texture after using soap. Therefore, the combination of coconut and olive oils results in a soap that is better at moisturizing and effectively nurturing the skin after use.

Comparison with Previous Research Results
The findings of this study align with earlier research indicating that both coconut oil and palm oil contribute significantly to the physical properties of natural soap, particularly in hardness and cleaning effectiveness. As reported by Félix et al. (2017), palm oil plays an essential role in enhancing soap durability, while coconut oil offers improved antibacterial properties and cleaning effectiveness. However, a difference was observed in the moisture testing, where the combination of coconut oil and olive oil provided superior moisturizing results. A limitation of this study is the relatively small sample size, which could affect the generalizability of the results. Future research with a larger sample size and broader oil compositions could provide more comprehensive insights into how vegetable oils impact soap quality.

CONCLUSION

This study successfully demonstrated the effect of different vegetable oil compositions (coconut, palm, and olive oils) on the physical and chemical properties of solid soap, particularly focusing on hardness, cleaning ability, and moisture retention. The results show that:

1. **Soap Hardness**: The formula with 60% coconut oil and 40% palm oil produced a harder soap, which is reflected in its increased durability. Palm oil, with its high saturated fat content, significantly contributes to soap hardness.
2. **Cleaning Ability**: The soap formula with 60% coconut oil and 40% palm oil exhibited superior cleaning performance, due to the antibacterial properties of lauric acid in coconut oil.
3. **Moisture Retention**: The soap with 60% coconut oil and 40% olive oil displayed the best moisture retention, with olive oil helping to maintain skin softness.

Overall, the study highlights the potential of combining various local vegetable oils to create high-quality natural soaps that can compete in both domestic and global markets.

RECOMMENDATIONS

1. **Development of Soap Formulas**: Based on the study's findings, it is recommended to develop soap formulas with a 60% coconut oil and 40% palm oil composition for the best quality in terms of hardness and cleaning ability. A combination of

coconut and olive oils is also suggested for soaps that provide enhanced moisturizing and skin care benefits.

2. **Further Research**: Future studies with a larger sample size and the inclusion of other vegetable oils, such as castor oil or argan oil, could offer deeper insights into how different vegetable oil compositions affect the quality of natural soaps.
3. **Further Testing According to Industry Standards**: Additional testing should be conducted to ensure that the soaps meet the standards set by the Indonesian National Standards (SNI) for solid soaps, and to explore the sustainability and eco-friendliness of the soap production process.
4. **Application in Industry**: The findings from this research should be applied in the local soap industry to reduce dependence on imported raw materials and improve the competitiveness of Indonesian natural soap products in the global market

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