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# Formulating Paper Soap with Coconut and Olive Oils: A Natural Solution for On-the-Go Hygiene

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**ABSTRACT:**
Paper soap served as a practical alternative for hand hygiene, especially for individuals with high mobility who required portable, lightweight, and hygienically stored products. This study aimed to formulate handwashing paper soap using a combination of coconut and olive oils, with potassium hydroxide (KOH) as the saponification agent, and to evaluate its quality based on the Indonesian National Standard (SNI) No. 2588:2017 for liquid hand soap.
A laboratory-based pure experimental method was used to determine the optimal combination of ingredients. The soap base formulation that showed the most favorable characteristics consisted of coconut oil and olive oil mixed in equal proportions, with KOH as the alkali. This combination produced a liquid soap with good cleansing ability, softness, and skin moisture retention. The evaluation results showed that the final formulation met all quality parameters: a pH value of 9.37, foam height of 10.5 cm, and free fatty acid content of 0.985%. Among the two types of paper tested, dry cotton tissue proved to be the most suitable medium for soap application due to its excellent absorbency and even drying.
Panelist testing further confirmed the acceptability of the product. Most respondents reported positive impressions regarding the product's texture, foaming properties, and skin feel after use. The paper soap did not cause irritation or a burning sensation, and it was easy to use and dispose of, increasing its appeal for daily use and travel.
In conclusion, the formulation successfully produced a functional and user-accepted paper soap that met national quality standards. The study demonstrated that natural ingredients could be effectively used to develop innovative hygiene solutions that are both practical and safe for everyday use.

**KEYWORDS:** Paper soap, Coconut oil, Olive oil, Potassium hydroxide, Natural antibacterial.

## INTRODUCTION:

In recent years, public awareness of hygiene and health in daily life had significantly increased. One of the most emphasized hygiene practices was handwashing, especially during the widespread outbreaks of viral infections across the globe. Governments and health organizations continuously reminded people to follow the 3M protocol—wearing masks, maintaining distance, and washing hands with soap. As a result, hand hygiene became a top priority in preventing disease transmission, reinforcing the importance of using soap in everyday activities.

Soap is categorized as a household health supply and pharmaceutical preparation that serves to clean dirt, germs, and impurities from the body. Among various types of soap, antiseptic soap had gained popularity due to its ability to reduce or prevent disease symptoms and microbial contamination on the skin. However, many commercial antiseptic soaps relied on synthetic antibacterial agents such as triclosan. Several studies had shown that excessive use of triclosan could harm the skin by disrupting its natural flora. For instance, (Gusviputri *et al.,* 2013) reported that triclosan could eliminate normal skin flora, which plays a protective role against pathogens like fungi.

Given these negative impacts, researchers began seeking alternative antibacterial ingredients derived from natural sources. Natural antibacterials were considered safer, more accessible, and less likely to cause resistance or side effects. One such natural ingredient was lime (Citrus aurantifolia), known for its antimicrobial activity. According to (Jayani *et al.,* 2018), hand soap containing 20% to 40% lime juice showed significant antiseptic effects, with increased concentrations correlating to greater antibacterial activity. This finding supported the potential of lime as a natural alternative to synthetic antibacterial agents in soap formulations.

At the same time, the demand for more practical and portable hygiene products grew. Consumers preferred soap that was lightweight, hygienically packaged, and easy to carry (Oktari *et al.*, 2017). In response to this need, paper soap emerged as an innovative solution. Paper soap is a thin, dry soap sheet that dissolves in water and can be used anywhere, offering both convenience and cleanliness. However, in Indonesia, the production of paper soap was still limited and largely dominated by imports from countries like China, highlighting a market gap and the need for local innovations in this area.

Based on these considerations, this research aimed to develop a handwashing paper soap using a combination of coconut oil and olive oil, with potassium hydroxide (KOH) as the saponifying agent. The formulation also incorporated lime juice as a natural antibacterial ingredient. The resulting product was evaluated for quality based on the Indonesian National Standard (SNI) No. 2588:2017 for liquid hand soap, including organoleptic testing, pH, foam stability, and free fatty acid/alkali content (Hutauruk *et al.,* 2020). Through this research, it was hoped that a safe, effective, and locally produced antibacterial paper soap could be introduced as an alternative to conventional antibacterial soaps.

## MATERIALS AND METHODS:

### Materials

The tools and materials used in this study included standard laboratory equipment such as glass beakers, measuring cylinders, stirring rods, a water bath, a digital pH meter, and titration apparatus for chemical analysis. For soap formulation, the main ingredients were coconut oil and olive oil as the fat sources, and potassium hydroxide (KOH) and sodium hydroxide (NaOH) as the saponification agents. Additional ingredients included glycerin for moisturizing, sodium lauryl sulfate (Texapon) to enhance foaming, and freshly extracted lime juice as a natural antibacterial agent. Distilled water was used throughout the process to ensure purity and consistency. For the paper soap application, two types of paper—wax paper and dry tissue paper—were tested to evaluate which provided the best absorption and usability.

### Preparation of Lime Juice

The preparation began with the extraction of lime juice (Citrus aurantifolia). Fresh, well-ripened limes were carefully selected to avoid both overripe and underripe fruits. The selected limes were thoroughly

washed under running water to remove surface impurities and then dried completely. Each lime was sliced in half, and the juice was manually squeezed and filtered to remove seeds and pulp. The filtered lime juice was collected in sterile glass bottles and stored in a refrigerator at a cool temperature of approximately 10–15°C until further use (Jayani *et al.,* 2018)

**Initial Ingredient Optimization: Oil and Alkali Types**

The optimization stage of the soap ingredients was carried out in two parts: oil type and alkali type. For oil optimization, separate batches of coconut oil and olive oil (10 g each) were heated in a water bath at 50–60°C and mixed with pre-dissolved alkalis (Hambali *et al.,* 2005). Both sodium hydroxide (NaOH) and potassium hydroxide (KOH) were tested, each dissolved in 4 g of distilled water at the same temperature to ensure uniformity. The alkaline solution was gradually added to the warm oil while stirring until a soap paste was formed. This procedure was repeated for all single and combined oil formulations, including mixtures of coconut and olive oil (10 g + 10 g), using both NaOH and KOH. Each variation was performed in triplicate to ensure reproducibility.

**Comparative Testing of Saponification Agents**

Further optimization focused on comparing the effects of NaOH and KOH as saponification agents across the different oil bases. The same method was used: 4 g of the chosen alkali dissolved in 4 g of heated distilled water was gradually added to 10 g of coconut oil, olive oil, or their combination (20 g total), all pre-heated to 50–60°C. The mixture was stirred continuously until a thick soap paste was formed. This step was also repeated in triplicate for consistency across all variations (Grosso, 2001).

**Final Soap Formulation Process**

The final soap formulation was developed using the optimized ingredients. The oil phase, consisting of 10 g coconut oil and 5 g olive oil, was mixed and heated. Separately, 4 g of KOH was dissolved in 4 g of warm distilled water to form the aqueous phase. The alkaline solution was gradually added to the oil phase while stirring to achieve homogeneity. Once a stable soap paste formed, additives were incorporated in the following order: 2 g of glycerin as a moisturizer, 1 g of sodium lauryl sulfate (Texapon) as a foaming agent, 5 g of lime juice as the active antibacterial ingredient, and distilled water up to 20 mL to adjust the final consistency. The soap was poured into a clean container for storage and evaluation. The final formulation was then subjected to physical and chemical quality testing according to Indonesian National Standard (SNI) 2588:2017 (BSN, 2017).

**Quality Testing and Paper Application**

The finished soap was tested using several quality control parameters. Organoleptic testing observed color, shape, and odor over a 2–4 week period (Hambali *et al.,* 2005). The pH test used a calibrated pH meter with 1 g of soap diluted in 10 mL of distilled water. Foam height was evaluated by vortexing 1 g of soap in 10 mL of water for one minute, with the resulting foam measured in centimeters. Free fatty acid and free alkali tests involved titration after refluxing the soap sample in ethanol and adjusting with either NaOH or HCl, depending on the observed color change. In addition, the soap was applied to different types of paper—wax paper and dry tissue paper—to determine the optimal medium for paper soap. After drying under sunlight for approximately 10 hours, the coated paper was cut into usable strips. Lastly, a sensory panel test involving 40 respondents evaluated soap characteristics such as smoothness, moisture, cleansing ability, foam quality, and skin sensation (e.g., irritation or warmth), with the results analyzed using Excel and presented as percentage graphs.

**RESULT:**

**Ingredient Optimization**

The optimization of oil types used in the soap formulation was presented in Table 1. The results showed that the combination of coconut oil and olive oil with KOH produced the best characteristics across all parameters, including softness, moisturization, foaming ability, cleansing power, and the absence of a heating sensation on the skin. This formulation received a "+++" (very good) rating for softness and "++" (good) for moisturization and cleansing properties, with no irritation reported. In contrast, soaps made with NaOH generally resulted in solid forms and less favorable skin feel, particularly in terms of

softness and moisturization. Olive oil combined with KOH alone also showed good results, particularly for skin feel, but the foam and cleansing performance were slightly lower than the combined oil formulation.

**Table 1.** *Optimization Results of Oil Types on Soap Characteristics*

| Oil Type | Softness | Moisture | Foaming | Cleansing | Warming Sensation |
|---|---|---|---|---|---|
| Coconut Oil + NaOH | - | - | + | ++ | ++ |
| Coconut Oil + KOH | + | + | + | + | - |
| Olive Oil + NaOH | + | + | - | + | + |
| Olive Oil + KOH | ++ | ++ | - | + | - |
| Coconut & Olive Oil + NaOH | + | + | + | ++ | + |
| Coconut & Olive Oil + KOH | +++ | ++ | + | ++ | - |

The next stage focused on optimizing the type of alkali, as shown in Table 2. It was found that formulations using KOH consistently produced liquid soap forms with superior characteristics, especially when combined with both coconut and olive oils. This formulation achieved the highest rating (+++) for softness, and good results for moisture retention, foaming, and cleansing. In contrast, formulations using NaOH resulted in solid soap with relatively poor softness and moisturizing performance. For instance, NaOH combined with coconut oil showed no moisturizing effect and caused a warming sensation on the skin, which could indicate potential irritation. These results confirmed that KOH was more suitable than NaOH for producing a liquid paper soap with desired sensory and functional properties.

**Table 2.** *Optimization Results of Alkali Types on Soap Characteristics*

| Alkali & Oil Type | Form | Softness | Moisture | Foaming | Cleansing | Warming Sensation |
|---|---|---|---|---|---|---|
| NaOH + Coconut Oil | Solid | - | - | + | ++ | ++ |
| NaOH + Olive Oil | Solid | + | + | - | + | + |
| NaOH + Coconut & Olive Oil | Solid | + | + | + | ++ | + |
| KOH + Coconut Oil | Liquid | + | + | + | + | - |
| KOH + Olive Oil | Liquid | ++ | ++ | - | + | - |
| KOH + Coconut & Olive Oil | Liquid | +++ | ++ | + | ++ | - |

**Formulation evaluation**

Following optimization, the final soap formulation was evaluated based on Indonesian National Standard (SNI) 2588:2017 criteria. As presented in Table 3, the soap met all required standards. The

organoleptic test described the product as a slightly viscous white liquid with a faint characteristic odor of oil. The pH of the soap was 9.37, which was within the acceptable range for personal hygiene products. Foam height reached 10.5 cm, indicating good foaming capacity, and the free fatty acid content (calculated as oleic acid) was 0.985%, also meeting the standard requirements. These results indicated that the formulated soap was physically and chemically stable and suitable for further application as a paper soap base.

**Table 3.** *Evaluation Results of Final Soap Formulation*

| Test Parameter | Result | Description |
|---|---|---|
| Organoleptic | Slightly viscous white liquid with mild oil scent | Meets standard |
| Ph | 9.37 | Meets standard |
| Foam Height | 10.5 cm | Meets standard |
| Free Fatty Acid Content | 0.985% | Meets standard |

The next step involved optimizing the type of paper used for creating the paper soap. Two types of paper were tested: dry cotton tissue and wax paper, with results shown in Table 4. Both types dried completely after approximately 10 hours under direct sunlight; however, the dry tissue paper achieved 97% even drying, compared to 90% for the wax paper. The tissue also showed better adherence to the soap formulation, resulting in a smoother and more uniform soap layer. This made the dry cotton tissue the more suitable choice for paper soap production in terms of performance and practicality.

**Table 4.** *Paper Type Optimization Results for Paper Soap Production*

| Paper Type | Soap Coating Result | Drying Rate | Drying Time |
|---|---|---|---|
| Dry Cotton Tissue | 97% evenly dried | Excellent | ±10 hours |
| Wax Paper | 90% evenly dried | Good | ±10 hours |

Overall, the optimized formulation—using a combination of coconut and olive oils saponified with KOH, resulted in a high-quality liquid soap with desirable sensory and cleansing properties. The use of lime juice further enhanced its natural antibacterial potential. When applied to dry cotton tissue, the soap formed a uniform and functional paper soap product that dried efficiently and maintained good usability. These results supported the feasibility of producing a practical and natural hand hygiene solution in the form of paper soap.

## DISCUSSION:

This study was conducted to address the increasing demand for practical, safe, and natural hygiene products, particularly in the wake of global awareness about hand hygiene (Gusviputri *et al.,* 2013). While conventional antibacterial soaps often rely on synthetic agents such as triclosan, which have been linked to adverse effects including disruption of the skin's normal flora, this research aimed to develop an alternative using natural ingredients. Lime juice (Citrus aurantifolia), known for its antibacterial properties, was chosen as the active component, while coconut and olive oils served as the soap base. The results confirmed that a combination of these two oils, saponified with potassium hydroxide (KOH), produced a high-quality soap with excellent characteristics, suggesting a safer and more environmentally friendly alternative (Jayani *et al.,* 2018).

The oil optimization tests highlighted that the blend of coconut and olive oil provided a balanced formulation, combining the cleansing strength of coconut oil with the moisturizing benefits of olive oil (Oktari *et al.,* 2017). When compared to single-oil formulations or those using sodium hydroxide (NaOH), the dual-oil mixture with KOH stood out in terms of softness, moisture retention, and overall skin compatibility (Hambali *et al.,* 2005). These findings supported the hypothesis that selecting the right combination of oils and alkali is essential in producing a functional soap base that meets consumer expectations for both efficacy and comfort.

From the alkali optimization perspective, KOH was proven to be more suitable than NaOH for creating liquid soap, which is critical for forming paper soap. NaOH consistently produced harder, solid soaps,

which were less compatible with the intended application. KOH, on the other hand, enabled the production of a viscous liquid that could be evenly applied to paper substrates. Among the tested papers, dry cotton tissue demonstrated the best absorption and drying performance, making it the most effective carrier for the paper soap. This confirmed the feasibility of creating portable, disposable soap in paper form—a solution that aligns well with modern hygiene needs and sustainability goals.

Ultimately, this study successfully met its objectives: it demonstrated that a natural, safe, and portable paper soap could be developed using a combination of coconut oil, olive oil, lime juice, and KOH. The product fulfilled the required quality standards (SNI 2588:2017) in terms of pH, foam height, and fatty acid content, while also showing favorable sensory characteristics in preliminary testing. By filling the gap in local production of paper soap and offering a triclosan-free alternative, this research provides a meaningful contribution to the development of innovative hygiene solutions based on natural ingredients.

## CONCLUSION:

Based on the findings of this study, it could be concluded that the optimal formulation for paper soap was achieved by combining coconut oil and olive oil as the base oils, with potassium hydroxide (KOH) as the alkali. This combination produced a soft, moisturizing, and effective soap with desirable cleansing and foaming properties, while avoiding the negative effects often associated with synthetic antibacterial agents like triclosan. The liquid soap formulation met the quality standards outlined in SNI 2588:2017, with a pH of 9.37, foam height of 10.5 cm, and free fatty acid content of 0.985%, confirming its suitability for personal hygiene use.

Furthermore, the optimized soap was successfully incorporated into a paper format using dry cotton tissue, which outperformed wax paper in terms of absorption and drying consistency.

## CONFLICT OF INTEREST

The authors have no conflicts of interest regarding this investigation**.**


## ACKNOWLEDGMENTS

Nil


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**ADDITIONAL INFORMATION**

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