Indonesian Journal of Contemporary Multidisciplinary Research (MODERN)
Vol.4, No.6, 2025: 229-240

Valorization of Pomelo Peel Essential Oil for the Formulation of Eco-Friendly Bar Soap

Ernawati Jassin[1], Ilham Ahmad[2*], Mursida[3], Fifi Arfini[4], Rahmaniar[5], Putri Ayu Ningsi[6], Imran Muhtar[7]
State Agricultural Polytechnic of Pangkajene Islands
Corresponding Author: Ilham Ahmad ilham.ahmad@polipangkep.ac.id

A R T I C L E I N F O

Keywords: Citrus Paradisi, Essential Oil, Pomelo Peel, Solid Soap, Sustainable Cosmetics

Received : 10 September
Revised : 12 October
Accepted: 30 November

A B S T R A C T

The increasing demand for natural and eco-friendly personal care products has encouraged innovation in utilizing agricultural waste. This study aimed to formulate bar soap using essential oil extracted from pomelo peel (*Citrus paradisi*) and evaluate its physicochemical, organoleptic, and antibacterial properties. Two formulations of vegetable oil (coconut, olive, and palm oil) and three concentrations of essential oil (0%, 2%, 4%) were tested using a factorial randomized complete design. Parameters assessed included pH, moisture content, total fatty matter, sensory attributes (texture, aroma, color, and foam), and antibacterial activity against Aeromonas sp.. The results showed that all formulations met the national quality standard (SNI 3532:2021), with the best outcome observed in the soap containing 4% essential oil and Formula 1 (15% coconut, 20% olive, 65% palm oil). This treatment produced soap with optimal pH (8), moisture (15.64%), fat content (81.78%), and favorable texture and foaming performance. However, antibacterial activity was limited, with inhibition zones measuring only 6.0–6.5 mm. The findings support the use of pomelo peel essential oil in sustainable soap production and encourage further research on enhancing its functional efficacy. This study contributes to the valorization of citrus waste and the advancement of natural cosmetics

DOI: https://doi.org/10.55927/modern.v4i6.16
E-ISSN: 2985-6108
https://journalmodern.my.id/index.php/MODERN/index

INTRODUCTION

The increasing global awareness of environmental sustainability and health safety has spurred a significant shift in consumer preferences toward naturally derived personal care products. A major concern associated with conventional synthetic cleansing products is their potential to cause skin irritation, dryness, and long-term exposure to toxic compounds, alongside contributing to environmental pollution due to their non-biodegradable residues (Uysal *et al*., 2011). In Indonesia, where household usage of cleansing products continues to rise with over 80% penetration, there is growing interest in developing personal care products from eco-friendly, biodegradable, and renewable raw materials (Setiawati & Ariani, 2021).

In line with this transition, the valorization of agricultural waste as a source of bioactive compounds has gained considerable momentum. One such underutilized waste is pomelo peel (*Citrus paradisi*), which constitutes approximately 27% of the total fruit mass. Often discarded, this peel is a rich source of essential oils, flavonoids, and pectins that exhibit antimicrobial, antioxidant, and anti-inflammatory properties (Guzmán & Lucía, 2021; Dao *et al*., 2022). Previous studies highlight that citrus essential oils, particularly those extracted from the peel, contain a high concentration of D-limonene, a compound known for its strong antibacterial and aromatic properties (Barqy, 2021). This has established a growing foundation for the development of functional cosmetic products using citrus-derived bioactive ingredients.

Amid the search for safer and greener alternatives, researchers have explored various fruit waste materials such as banana peels, dragon fruit skins, and sweet orange rinds in soap formulation. These studies demonstrated improved functional properties including antioxidant activity, skin moisturizing effects, and better user acceptability (Mardiana *et al*., 2022; Januarti *et al*., 2023; Noviarni & Ningsih, 2024). However, the application of pomelo peel essential oil in solid soap remains notably scarce in the literature. Despite the promising properties of pomelo peel, including its essential oil content and high-value bioactives, the material has yet to be fully explored in hygiene product formulations.

Synthetic soap bases generally contain detergents and preservatives that can strip the skin of natural oils and disrupt its protective barrier. This has prompted the formulation of soaps using vegetable oils such as coconut, olive, and palm oil, which not only improve the emollient properties of soap but also serve as carriers for functional additives like essential oils. Essential oils, due to their volatility and lipophilic nature, can be incorporated into these formulations to deliver aroma, antibacterial activity, and skin-conditioning benefits (Chao *et al*., 2008). Nonetheless, the concentration and compatibility of these oils within the soap matrix require empirical validation to ensure their effectiveness and stability.

Among citrus species, pomelo peel essential oil stands out due to its composition. Studies report that the oil contains up to 73% D-limonene, along with citral, linalool, and geraniol—compounds that collectively contribute to its antibacterial, antifungal, and antioxidant actions (Barqy, 2021; Dao *et al*., 2022).

These properties, coupled with its pleasant citrus aroma, make pomelo essential oil an ideal candidate for inclusion in natural soap formulations. Furthermore, the use of citrus waste aligns with principles of circular economy and sustainable production by minimizing waste and transforming it into value-added products (Umar *et al*., 2017).

Recent technological advancements have enabled the efficient extraction of high-purity essential oils from citrus peels, using methods such as steam distillation and microwave-assisted extraction (Zhang *et al*., 2022). These innovations support the scalability of using citrus peel oils in cosmetics, but few studies have examined their impact when integrated into a soap base. A key gap exists in understanding how the concentration of pomelo peel essential oil affects physicochemical properties of solid soap, such as pH, moisture retention, total fatty matter, and sensory attributes. This information is crucial to optimize product formulation and to meet national standards such as SNI 3532:2021 in Indonesia.

Given this context, the present study aims to formulate and evaluate bar soaps incorporating essential oil extracted from pomelo peel and various combinations of vegetable oils. The goal is to assess how different concentrations of pomelo oil (0%, 2%, and 4%) and oil base compositions influence the soap's physical, chemical, and organoleptic properties. This study also includes antibacterial testing against Aeromonas sp., a common skin pathogen, to evaluate the potential of the soap as a functional hygiene product.

This research is novel in its specific focus on pomelo (*Citrus paradisi*) peel essential oil as a functional additive in solid soap. It also contributes empirical data to the limited body of work evaluating agricultural waste in natural hygiene product development. By adhering to Indonesian soap quality standards and incorporating biodegradable materials, this study demonstrates the feasibility of producing high-quality, eco-friendly bar soaps suitable for sustainable markets. The findings are expected to inform future research in natural product formulations and waste valorization strategies in cosmetic and personal care industries.

LITERATURE REVIEW

Pomelo, scientifically known as *Citrus paradisi*, is a citrus species widely cultivated in tropical and subtropical regions. In Indonesia, pomelo is an economically significant fruit, particularly in provinces such as South Sulawesi and East Java (Yanti *et al*., 2021). The peel constitutes approximately 27% of the fruit's total mass and is typically discarded as waste. However, this by-product is rich in bioactive compounds such as flavonoids, limonene, and pectin, which are known for their antimicrobial, antioxidant, and anti-inflammatory properties (Lie & Alzura, 2021; Sahlan *et al*., 2018). Flavonoids such as naringin and hesperidin have shown potential in metabolic regulation and immune function, indicating the pharmacological relevance of pomelo peel (Ulla *et al*., 2018).

Essential oil derived from pomelo peel is obtained via steam distillation and contains volatile compounds including D-limonene, citral, linalool, and geraniol. Among these, D-limonene is typically the most abundant, comprising up to 73% of the oil, and contributes significantly to the oil's antimicrobial and aromatic properties (Barqy, 2021; Dao *et al*., 2022). Several studies have highlighted the potential of citrus essential oils in personal care and pharmaceutical products due to their antibacterial and antifungal activity (Chao *et al*., 2008; Guzmán & Lucía, 2021). Technological advancements such as microwave-assisted distillation have further improved the efficiency and yield of essential oil extraction from citrus peels (Zhang *et al*., 2022).

Solid soap is traditionally produced through saponification, a chemical reaction between fats/oils and an alkali, typically sodium hydroxide (NaOH). Vegetable oils such as coconut, olive, and palm oil are commonly used due to their emollient properties and foam-producing ability (Fanani *et al*., 2020). Incorporating natural additives, including essential oils and herbal extracts, has gained traction for enhancing the functional and sensory attributes of soap. Essential oils provide not only fragrance but also biological benefits such as antimicrobial, antifungal, and antioxidant effects (Widyaningsih *et al*., 2023). However, their integration into soap formulations must be carefully controlled, as high temperatures during saponification can degrade volatile compounds (Odeyemi *et al*., 2019).

Numerous studies have examined the use of fruit peel waste in cosmetic formulations. Mardiana *et al*. (2022) utilized banana peel extract in bar soap, reporting significant antioxidant properties. Similarly, Januarti *et al*. (2023) formulated liquid soap with dragon fruit peel extract, which enhanced skin moisture and user acceptability. Noviarni and Ningsih (2024) demonstrated that the inclusion of Gerga orange peel in soap increased antioxidant activity and met national quality standards. Patil *et al*. (2023) explored the use of citrus waste in vegan soap production, promoting environmental sustainability and waste reduction. These studies collectively support the viability of using citrus peels, including pomelo, in the development of eco-friendly hygiene products.

METHODOLOGY

This research was conducted from March to May 2025 at the Non-Food TEFA Laboratory of Politeknik Pertanian Negeri Pangkep.

Materials and Equipment

Materials used in this study included essential oil extracted from pomelo peel (*Citrus paradisi*), vegetable oils such as coconut oil, olive oil, and palm oil, sodium hydroxide (NaOH), and distilled water. Equipment included a digital balance, heat-resistant mixing containers, distillation apparatus, soap molds, pH meters, ovens, and analytical instruments.

Experimental Design

The study used a factorial randomized complete design (RCBD) with two factors. Factor A was the vegetable oil formulation: Formula 1 (15% coconut, 20% olive, 65% palm oil) and Formula 2 (30% coconut, 20% olive, 50% palm oil). Factor B was the essential oil concentration: 0%, 2%, and 4%. Each combination (A1B0, A1B1, A1B2, A2B0, A2B1, A2B2) was replicated three times.

Soap Production Procedures

Essential oil was extracted from pomelo peel using steam distillation. The cleaned and chopped peel was submerged in water in a distillation flask, then heated to extract the oil, which was collected and purified.

NaOH solution was prepared by dissolving 13 g of NaOH in 22 g of water and cooled to 40°C. Pre-weighed vegetable oils were mixed, and NaOH solution was added gradually with continuous stirring until trace. Essential oil was added as per treatment, followed by molding and curing for 3 weeks.

Evaluation Parameters

- Organoleptic Testing
  Involved 15 untrained panelists who evaluated color, aroma, texture, and foam using a 5-point hedonic scale. Participants were screened for allergies and sensory ability.
- pH Measurement
  1 g of soap was dissolved in 10 ml of warm distilled water. A pH strip was immersed in the solution to record pH values.
- Moisture Content
  2 g of soap was oven-dried at 105°C until constant weight. Moisture content was calculated as the percentage of weight lost.
- Total Fatty Matter
  5 g of soap was hydrolyzed using ethanol and HCl. The residue was filtered, washed, dried at 105°C, and weighed to determine fat content.
- Antibacterial Activity
  Soap cubes were placed on nutrient agar inoculated with Aeromonas sp., then incubated at 37°C for 24 hours. Inhibition zones were measured in mm. Erythromycin was used as a positive control and distilled water as a negative control.

Statistical Analysis

Data were analyzed using ANOVA in SPSS version 27. Duncan's Multiple Range Test (DMRT) was used to identify significant differences at $p<0.05$.

RESEARCH RESULT

pH Value

The pH values of all bar soap samples were consistently measured at 8 across all tr eatment combinations, regardless of the formulation of vegetable oils or the concentration of pomelo peel essential oil. This value falls within the acceptable range specified by Indonesian National Standards (SNI 3532:2021), which require pH values to be between 6 and 11. The stability of pH values across all treatments indicates that the addition of essential oil in concentrations up to 4% did not significantly alter the alkalinity of the soap base. These results confirm the chemical stability of the formulations and their suitability for safe topical use.

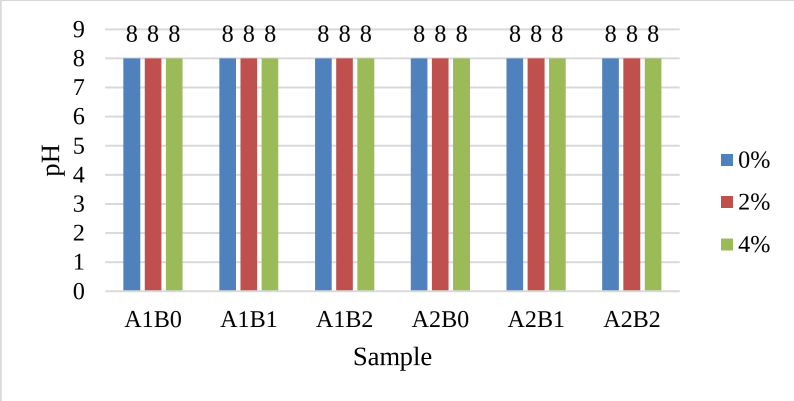

Figure 1. Graph of Solid Soap pH Results

Moisture Content

Moisture content ranged from 15.64% to 16.53% across treatments. The highest moisture content was observed in A2B2 (16.53%), and the lowest in A2B0 (15.64%). All values remained below the SNI maximum of 23%, signifying good product stability and resistance to microbial contamination. ANOVA results revealed that essential oil concentration had a statistically significant effect on moisture content ($p<0.05$), while the vegetable oil formula did not ($p>0.05$). A significant interaction effect was also noted between formula and essential oil concentration, indicating that the response in moisture varied depending on the specific formulation and oil concentration.

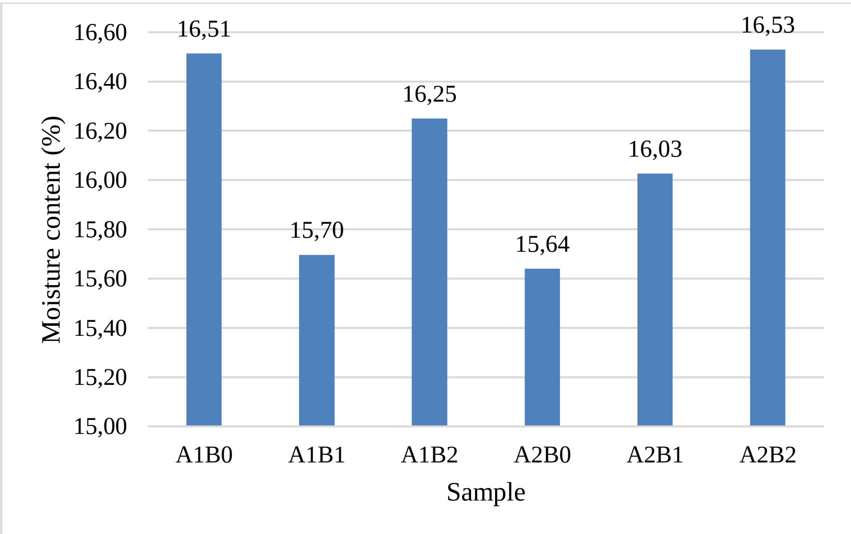

Figure 2. Graph of Water Content Test Results for Solid Soap

Total Fatty Matter

The percentage of Total Fatty Matter (TFM) ranged from 72.67% to 81.78%. The highest value was recorded in A1B2, which contained 4% essential oil with Formula 1, while the lowest was found in A1B0. All soap samples exceeded the minimum TFM requirement of 60% as per SNI 3532:2021, suggesting optimal saponification and high-quality soap structure. Increased concentrations of essential oil were associated with higher fat content, potentially due to the unreacted components of the essential oil such as limonene, contributing to the fatty profile of the soap.

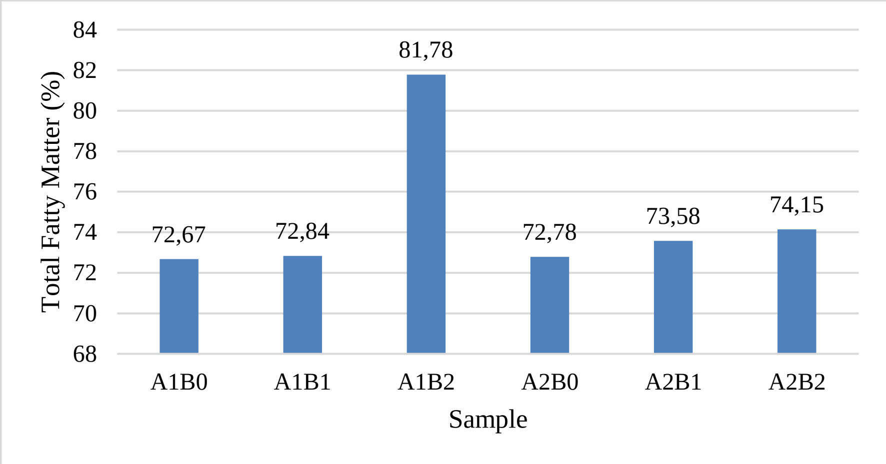

Figure 3. Graph of Solid Soap Fat Content Test Results

Organoleptic Properties

Texture

Panelist evaluations showed that most soap samples with 2% and 4% essential oil (A1B1, A1B2, A2B1, A2B2) scored a 4 on the hedonic scale, indicating 'like.' Samples without essential oil (A1B0, A2B0) scored a 3, indicating 'neutral.' ANOVA results demonstrated a significant effect of essential oil concentration on texture ($p<0.05$), while the vegetable oil formulation showed no significant effect. The addition of essential oil improved soap softness and pliability, possibly by disrupting the crystalline structure of the soap matrix.

Aroma

All samples scored a 4 on aroma, except A2B0, which received a 3. Surprisingly, A1B0 (no essential oil) received a higher score than A2B0, implying that the oil blend in Formula 1 may contribute a more pleasant base aroma. ANOVA revealed no significant effects from either factor or their interaction on aroma ($p>0.05$), suggesting the essential oil concentration used was not strong enough to influence perceived scent significantly.

Color

All samples received a consistent score of 4 for color. This uniformity indicates that neither the vegetable oil formulations nor the essential oil concentrations caused noticeable visual differences. The absence of significant differences was confirmed by ANOVA ($p>0.05$).

Foam

All samples were rated 4 for foam volume and stability. ANOVA indicated that essential oil concentration had a significant effect ($p<0.05$), but no effect was observed from vegetable oil formulation or their interaction. Duncan post hoc tests showed that 4% essential oil (B2) slightly improved foam ratings, although differences were not statistically substantial.

Antibacterial Activity

The antibacterial activity against Aeromonas sp. was weak across all samples, with inhibition zones ranging from 6.0 to 6.5 mm. These results fall within the 'low activity' category based on CLSI guidelines. Compared to the positive control (erythromycin, 17.5 mm), the soap's efficacy was minimal. The low activity could be attributed to the relatively low concentration of essential oil, possible volatility loss during saponification, and the inherent resistance of Gram-negative Aeromonas sp. to essential oils. However, the slight inhibitory effect suggests potential for enhancement in future formulations with higher essential oil concentrations or different active components.

DISCUSSION

The formulation of bar soap using essential oil from pomelo peel (*Citrus paradisi*) demonstrated promising results in enhancing physicochemical and organoleptic properties while aligning with the growing consumer demand for natural and sustainable personal care products. The uniform pH value of 8 across all treatments suggests that the inclusion of essential oil at tested concentrations did not disrupt the alkalinity balance of the soap. This is critical, as soaps with pH levels within the recommended range are less likely to cause skin irritation, maintaining skin integrity and user comfort (Prasetiyo *et al*., 2022).

The observed increase in moisture content with higher essential oil concentrations aligns with the findings of Silva *et al*. (2021), who noted that essential oils may retain water due to their emulsifying behavior and possible interference with matrix structure. While all formulations met the maximum moisture threshold according to SNI standards, the significant effect of essential oil concentration on moisture content suggests a need for careful calibration to avoid product softening or microbial growth during storage. This highlights a trade-off between sensory enhancement and physical stability that requires optimization.

Similarly, the increase in total fatty matter with essential oil addition—particularly in the A1B2 formulation—indicates the contribution of lipophilic compounds like limonene to the soap's fat profile. This supports findings by Odeyemi *et al*. (2019), who reported that essential oil-enriched soaps exhibit higher fatty content, possibly due to unreacted hydrophobic molecules. These residual lipids may enhance the moisturizing effect of the soap, thereby improving consumer experience without compromising the structural integrity of the product.

In organoleptic testing, texture and foaming properties improved significantly with the inclusion of essential oil, while color and aroma remained relatively unaffected. The enhancement in texture may result from the plasticizing effect of essential oil components, which alter the crystalline alignment of soap molecules, yielding a softer and more pliable structure (Rahmawati *et al*., 2021). This agrees with the study by Jha *et al*. (2020), who found that essential oils improve the tactile qualities of soap bars.

The aroma scores, while consistent across treatments, revealed that base formulation also plays a role in fragrance perception, as evidenced by higher ratings for A1B0 compared to A2B0. This suggests that some vegetable oils possess inherent aromatic profiles that may synergize or compete with added essential oils. Given the volatility of essential oils during saponification, as discussed by Zhang *et al*. (2022), the aromatic contribution of added oils may be diminished unless post-processing techniques are employed to retain scent integrity.

Foam stability is an essential quality determinant for consumer satisfaction. The observed improvement in foaming with higher essential oil concentrations reflects findings by Fanani *et al*. (2020), who linked essential oil addition to enhanced emulsification and surfactant action in soap systems. However, while differences in foam were statistically significant, the practical difference in user experience may be minimal, indicating that even lower concentrations of essential oil may suffice to achieve desired foaming characteristics.

The antibacterial test results, showing weak inhibition of Aeromonas sp., underscore a limitation in the bioactivity of the tested formulations. Although D-limonene and citral have been documented for their antimicrobial efficacy (Chao *et al*., 2008; Barqy, 2021), their potency is highly dependent on concentration, stability, and diffusion capacity within the soap matrix. Moreover, the inherent resistance of Gram-negative bacteria such as Aeromonas due to their complex outer membrane structures may further reduce the effectiveness of essential oils (Nugraheni *et al*., 2020). These findings are consistent with Nababan *et al*. (2021), who observed limited inhibition zones in solid soap systems unless higher essential oil loads or synergistic antimicrobials were included.

While the primary function of bar soap remains physical cleansing, the addition of functional ingredients like essential oils can offer secondary benefits such as skin conditioning, sensory enhancement, and, to a lesser extent, antimicrobial support. However, this study highlights that essential oil concentration must be optimized not only for sensory performance but also for ensuring bioactivity and maintaining physicochemical stability. Further studies could explore the incorporation of microencapsulation techniques to protect volatile bioactives during saponification and curing, potentially enhancing antimicrobial efficacy and scent retention.

The research also contributes to the broader discourse on sustainable cosmetics by demonstrating the feasibility of utilizing agricultural waste—pomelo peel—as a functional component in hygiene products. This aligns with circular economy principles and supports waste valorization efforts in agro-industrial contexts. In resource-abundant regions like Indonesia, where citrus production generates significant organic waste, such innovations hold promise for both environmental and economic benefits.

However, several limitations of the study must be acknowledged. The antibacterial assay focused on a single microorganism and may not represent broader microbial efficacy. Additionally, organoleptic testing involved untrained panelists, which may introduce subjective bias. The stability of essential oils over long-term storage and their interaction with soap aging processes also warrant further investigation.

CONCLUSIONS AND RECOMENDATIONS

This study demonstrated that the incorporation of pomelo peel (*Citrus paradisi*) essential oil into bar soap formulations can significantly enhance the product's physicochemical and sensory properties while aligning with national quality standards. Soaps formulated with a blend of 15% coconut oil, 20% olive oil, and 65% palm oil, along with a 4% addition of essential oil, exhibited the most favorable characteristics in terms of pH (8), moisture content (15.64%), and total fatty matter (81.78%). Organoleptic evaluations showed improved texture and foaming performance without negatively affecting color or aroma. Although the antibacterial effect against Aeromonas sp. was weak, the soap still presented hygienic functionality primarily through mechanical cleansing. These results highlight the potential of utilizing agricultural waste as a value-added component in personal care formulations. The study supports sustainable product development and encourages further exploration into enhancing bioactivity and essential oil stability. Future research should investigate broader antimicrobial efficacy, long-term storage stability, and consumer acceptance to fully realize the application of citrus-based bioactives in eco-friendly soap production.

ACKNOWLEDGMENT

We would like to thank the Director of the Pangkajene Islands State Agricultural Polytechnic for providing funding and facilities to facilitate this research. We also extend our gratitude to our colleagues and all parties who assisted in this research.

REFERENCES

Barqy, N. (2021). Review: Senyawa penyusun minyak atsiri kulit jeruk bali (*Citrus paradisi*) dan aktivitas farmakologinya. Jurnal Dunia Farmasi, 5(2), 89–98.

Chao, S., Young, G. C., Oberg, C. J., & Nakaoka, K. (2008). Inhibition of methicillin-resistant Staphylococcus aureus (MRSA) by essential oils. Flavour and Fragrance Journal, 23(6), 444–449.

Dao, P. T., Tran, N. Y. T., Tran, Q. N., Bach, G. L., & Lam, T. V. K. (2022). Kinetic models of essential oil extraction from pomelo (*Citrus paradisi*) peels. Alexandria Engineering Journal, 61(3), 2564–2572.

Fanani, Z., Panangan, A. T., & Apriyani, N. (2020). Uji kualitas sabun padat transparan dari minyak kelapa dan minyak kelapa sawit dengan antioksidan ekstrak likopen buah tomat. Jurnal Penelitian Sains, 22(3), 108–118.

Guzmán, E., & Lucía, A. (2021). Essential oils and their individual components in cosmetic products. Cosmetics, 8(4), 114.

Januarti, M., Husni, P., & Eryani, M. C. (2023). Utilization of dragon fruit peel extract (Hylocereus polyrhizus) as an active ingredient in the production of natural liquid soap. Jurnal Farmasi Galenika, 11(3), 178–189.

Jha, S., Singh, R., & Kumar, R. (2020). Effect of essential oils on the physicochemical properties of soap bars. Journal of Surfactants and Detergents, 23(2), 345–353.

Lie, D., & Alzura, F. A. (2021). Sitrus: Inovasi sabun kertas berbasis limbah kulit jeruk di tengah pandemi COVID-19. Berkala Ilmiah Mahasiswa Farmasi Indonesia (BIMFI), 8(2), 54–63.

Mardiana, R., Yuniati, Y., & Dita, S. F. (2022). Pemanfaatan limbah organik kulit pisang awak (Musa balbisiana) sebagai bahan sediaan sabun padat untuk menangkal radikal bebas. Lantanida Journal, 10(1), 34.

Noviarni, I., & Ningsih, S. (2024). Physiochemical characteristic and antioxidant of solid bath soap containing Gerga orange (Citrus nobilis L. var. RGL) peel. Al-Kimia, 12(1).

Nugraheni, N. D., Widyaningrum, R., & Pratiwi, D. R. (2020). Pengaruh formulasi minyak atsiri terhadap aktivitas antibakteri sabun padat herbal. Jurnal Farmasi Sains dan Komunitas, 17(1), 56–62. https://doi.org/10.24071/jpsc.v17i1.2700

Odeyemi, O. A., Oloke, J. K., & Adegoke, A. A. (2019). Influence of essential oil concentration on the saponification and moisture retention of natural soaps. International Journal of Cosmetic Science, 41(4), 421–429.

Patil, N. R., Chaudhari, B., Chaudhari, M., Goske, S., & Dhutale, S. (2023). Vegan soap from waste organic material. International Journal of Membrane Science and Technology.

Prasetiyo, A., Yantih, N., Yamin, M., Hutagaol, L., & Nawasiah, N. (2022). Pembuatan sabun padat transparan menuju santri yang memiliki jiwa kewirausahaan. Jurnal Abdimas, 4(1), 33–38.

Rahmawati, D., Yuliani, R., & Azizah, N. (2021). Pengaruh konsentrasi minyak atsiri terhadap karakteristik fisik dan organoleptik sabun padat transparan. Jurnal Ilmu dan Teknologi Pangan, 15(1), 45–52.

Sahlan, M., Damayanti, V., Tristantini, D., Hermansyah, H., Wijanarko, A., & Olivia, Y. (2018). Antimicrobial activities of pomelo (*Citrus paradisi*) seed and pulp ethanolic extract.

Setiawati, I., & Ariani, A. (2021). Kajian pH dan kadar air dalam SNI sabun mandi padat di Jabedebog. Pertemuan dan Presentasi Ilmiah Standardisasi, 293–300.

Silva, M. L., Carvalho, A. R., & Santos, F. A. (2021). Moisture content variation in essential oil-enriched soaps during curing process. Journal of Cosmetic Science, 72(5), 259–267.

Ulla, A., Alam, M. A., & Alam, M. (2018). Therapeutic potential of citrus flavonoids and their molecular mechanism of action. International Journal of Molecular Sciences, 19(6), 1916.

Umar, A. G., *et al*. (2017). Citrus peel essential oils: A review on composition and antimicrobial activities. International Journal of Biosciences, 10(3), 205–215.

Yanti, D., Nahraeni, W., Masithoh, S., & Rahayu, A. (2021). Analisis risiko usahatani jeruk bali: Kasus di Desa Tambakmas Kecamatan Sukomoro Kabupaten Magetan. Jurnal Agribisains, 7(1), 11–23.

Zhang, X., Huang, Y., Niu, Y., Liu, Z., Chen, M., An, Y., & Zhang, L. (2022). The preparation of the essential oil from pomelo (*Citrus paradisi*) peel using microwave-assisted distillation by pectinase soaking and its anti-fungal activity. Separations, 9(7), 161.