Application of coconut oil from Ben Tre Province (Vietnam) as the main detergent for body wash products

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Abstract. Coconut oil is considered the active ingredient as a moisturizer used by many people in tropical regions. At the same time, coconut oil can improve the symptoms of skin disorders by moisturizing and soothing the skin. A body wash formula that contains coconut oil based on the saponification process is formulated through an appropriate content survey. The combination of auxiliary substances such as detergent, foaming agent, moisturizing agent, preservative was also conducted to evaluate different concentrations. Products are assessed and visually observed for appearance, viscosity, pH value, stability, and durability when stored. The body wash formula was found to be white and pearl luster was visually observed. Products using 20% crude soap content, 5% detergent (SLES), 3% glycerin, etc. have all been tested to show good physico-chemical properties in terms of pH value and viscosity, as well as no irritation, upon skin contact. Research shows that coconut oil body wash formulas with good physico-chemical properties can be developed into new body wash cosmetic products.

1. Introduction
Daily exposure to air pollution and sun rays is known as main cause of women’s skin damage. That is why a series of skincare products are regularly being launched, which have been meeting the above demand. On the other hand, there are quite a lot of bath products with different features, and most of them contain primary surfactants such as sodium laureth ether sulfate (SLES), sodium lauryl sulfate, disodium lauryl sulfosuccinate and sodium cocoylisothionate. They all have strong cleansing
capabilities that can dry out the skin. The formula of body wash products with main ingredients from nature is currently favorable [1]–[3].

Coconut oil is a type of fat extracted from copra and is widely used in the field of food and pharmaceuticals worldwide [4]–[6]. Because of its high saturated fat content, it can be less oxidized and stored up to two years. Coconut oil is currently used in many fields, especially in cosmetics, which is very popular and attracts consumers’ attention. Coconut oil contains high levels of saturated fatty acids such as palmitic acid (7–10%), myristic acid (16–21%), lauric acid (45–56%), caprylic acid, capric acid, stearic acid and oleic acid. In terms of nutritional value, coconut oil has been proven to be very good for the cardiovascular and digestion system [7].

Varmaet et al. have demonstrated the highest anti-inflammatory activity of coconut oil by inhibiting inflammatory markers and protecting the skin by strengthening the skin barrier function [8]. Burnett et al. mentioned in the research that in cosmetic products, coconut oil is used as a foaming agent, stabilizer, and detergent with concentrations up to 50%. There are no indications that these ingredients are sensitizing, primary stimulants, or toxic photosynthetic compounds after human testing. No skin irritation or any sensitization caused by coconut oil [9].

Besides, coconut oil antioxidant activity has been interested in scientists in the world in recent years [10]–[13]. Nevin et al. studied the effects of coconut oil on antioxidant enzymes’ activity and fat peroxidation levels in male mice Sprague Daw Dawley [14]. Besides, the coconut oil contains polyphenols, which are antioxidants and prevent lipid peroxidation under both in vitro and in vivo conditions, which leads to improved health benefits related to antioxidants; and research results are published in Food Chemistry [14]. From the research results of scientists published in prestigious scientific journals, coconut oil can be used as an ingredient that can create fragrances, conditioners for hair, or moisturizers for skin and was reported in cosmetics in concentrations ranging from 0.0001% to 70%. Coconut oil is as safe as other cosmetic ingredients in use, and the concentrations are described in safety assessments [9], [13], [15], [16].

Therefore, the investment in research and development of coconut products, taking advantage of available raw materials to research high-quality body wash products, is the increasing demand of the market. However, the product lines from coconut applied in body wash products on the Vietnamese market are currently not many and not diverse. Thus, with the potential of coconut oil available in Ben Tre, the locality can fully take the initiative in the source of raw materials to produce natural cosmetic products from coconut oil. In this study, the leading detergent in the body wash was provided by the saponification process of coconut oil with the right content. The product is blended with several other active ingredients such as foaming, thickening, coloring, and aromatic essential oils to enhance the shower gel’s aesthetics Therefore, the research objective is to produce bath products using coconut oil as raw material. This product can enhance the use value and income for local people in Ben Tre Province. Natural body wash products is safe and highly biodegradable materials will contribute to environmental protection and sustainable economic development.

2. Material and methods

2.1. Raw materials and chemicals
Coconut oil used in this study is virgin coconut oil purchased from VietCoCo products of Luong Quoi Coconut Processing Co., Ltd, Chau Thanh District, Ben Tre Province (Vietnam). Coconut oil meets Vietnamese standards (TCVN 7597: 2013) through the process of evaluating physical and chemical properties.

The chemicals used: Sodium Hydroxide (NaOH), sodium lauryl ether sulfate (SLES) as detergents, Glycerin as humectants, Cocamidopropyl betaine (CAPB) as foaming agent and Repoly 100 as thickeners were purchased at Nguyen Ba Trading Production Co., Ltd, Tan Binh District, Ho Chi Minh City.
2.2. Saponification process
The process of saponification follows previous studies by the authors [6]. Conducting the saponification process is based on a combination of an alkaline solution (NaOH) with a coconut oil ratio of 1: 5 (g / g), of which the alkali content is 11%. The mixture was stirred well and kept reaction time for 3 hours, at a reaction temperature of 85ºC. The crude soap base is checked with basic parameters such as pH value, viscosity, foaming, foam strength, and emulsifying ability and cleaning ability.

2.3. The process of mixing of body wash
First, the saponification process is carried out: the reaction creates soap with alkali to make crude soap. Then weigh the exact amount of SLES and H2O stir until entirely completely together. Continue adding the obtained natural soap to the stirring mixture until dissolved. The formula’s ingredients will be examined at different levels and selected appropriate content to add to the formula. Add additives, including auxiliary cleaners, moisturizers, softeners, preservatives, etc. and part of the water, is are dissolved together and stirred gently, and proceed heat (if necessary). Colors and scent were added to enhance the sensory value and diversify products. Also, add electrolyte and dissolved pH adjustment solution to the solution.

2.4. Methods of determining the physical properties of products
- Viscosity: The viscosity of liquid products can be checked by NDJ-9S viscometer
- pH value: Use the Consort pH meter (C3010)
- Foamability: This study uses the shaking test to measure foaming. The liquid is diluted 100 time, and then 5 ml of solution is placed in a stoppered tube, shaking with a moderate force until the maximum amount of foam generated (foam volume does not change).
  - Foamability was calculated by the formula:
    \[ \varepsilon_f = \frac{V_{\text{foam}} - V_{\text{liquid}}}{V_{\text{foam}}} \]
    with \( \varepsilon_f \): foamability; \( V_{\text{foam}} \): foam volume after shaking; and \( V_{\text{liquid}} \): initial liquid volume.
- Emulsion durability: The cleaning effect is shown by the time of emulsification, with selected paraffin oil (simulated for dirt).

2.5. Sensory evaluation method of users
Surveying any 20 people (10 men + 10 women), the evaluation factors are expressed on a scale according to the sensory perception method. In particular, the largest scale is 5 points for the most popular product and the descending scale from the favorite, and lowest in the level of dislike for the zero scales. Factors are assessed as product background, foam level, feeling of use, and product preference level.

3. Result and discussion

3.1. Effect of crude soap
The content of crude soap was surveyed from 10 to 50%. The survey results are shown in figure 1. The foam volume increases with increasing the soap content from 10 to 20% and reaches the highest value at 20% (foamability 0.612, foam durability 0.569). Then decrease gradually when increasing the range to 50%. Therefore, simple soap will be selected with a 20% content to investigate the next factor. In terms of the time of emulsification, samples containing 20% crude soap content had the most extended delamination period under the influence of paraffin oil and tended to decrease when increasing the range from 20%–50%.
3.2. Effect of Sodium Lauryl Ether Sulfate (SLES) detergent

The surfactant used is Sodium lauryl ether sulfate (SLES). The content of SLES is investigated from 0 to 10%. From the results of figure 2, foam volume did not change when increasing SLES content from 0 to 5%. But when the content increased to 5%, the foamy stability increased significantly to reach the highest value of 0.612 and also the content that the sample had the most durable time of 12.05 minutes. After that, the foamy stability decreases with increasing content from 7.5–10% (foamability from 0.593 to 0.573). At the same time, adding EDTA (0.1%) to isolate heavy metal ions, creating stability, also helps prevent the product from being affected by chemical reactions between metals and other active substances. Therefore, the selected SLES content is 5% for the follow-up survey.

3.3. Effect of glycerin humectants

The study results on glycerin content using from 1 to 5%, were obtained, as shown in figure 3. However, there was an apparent change in the range of 3% (formability 0.580). Simultaneously, when evaluating the time of emulsion durability of the sample at 3%, it is the most durable compared to the other content. In comparison, larger values tend to reduce the foam and their stability. On the other hand, glycerin is a benign active substance, suitable for all skin types. It has a high strength besides good foaming ability, so the use of this agent in the product is appropriate for the work’s original purpose. Therefore, to ensure the ability to cleanse, and moisturize the skin after use, glycerin is selected to be 3% content to investigate the next factor.
3.4. Effect of Cocamidopropyl Betaine (CAPB) foaming agent

Cocamidopropyl betaine (CAPB) works to help foam and stabilize the foam, while thickening the product and reducing skin irritation. CAPB content was ranged from 0 to 10%. The results are shown in figure 4. From figure 4, when increasing the CAPB content from 0 to 5%, the foam volume increases and tends to decrease when increasing the range from 5 to 10%. The highest foamability at CAPB 5% content with 0.593 foamability and 0.573 foam durability. On the other hand, the samples increased gradually from 0% to 7.5% in terms of emulsion durability. They tended to decrease at the content of 10%, reaching the highest value at the content of 7.5% with 11.43 minutes. However, at 5% with a stable time of 11.32 minutes, there was not much difference, combined with the ability to create foam, the CAPB content was selected as 5% to investigate the next factors.

Figure 3. The effect of Glycerin on foamability and emulsion durability.

Figure 4. The effect of CAPB on foamability and emulsion durability.

3.5. Effect of P2000 UP and PEG-7 auxiliary cleaners

The two auxiliary cleaners selected for the survey were plantacare 2000 UP and PEG-7. The total amount of chosen additional detergentis 5%. The survey results are shown in figure 5.

According to the results of figure 5, in general, when increasing plantacare 2000 UP content and decreasing PEG-7 content, the foam volume increased. Therefore, use the plantacare 2000 UP auxiliary...
cleanser without the need for combination with PEG-7. Thus, the next section will examine plantacare 2000 UP content to add to the research product.

Plantacare 2000 UP content was surveyed from 0 to 4%. The influence of P2000 on the foaming and the time of emulsification are shown in figure 6. According to the results of Figure 6, the foam volume changes irregularly when the plantacare 2000 UP content is increased. Specifically, when adding 2% of the substance, the product shows the best cleaning ability (foamability 0.6, foam durability 0.573). The time to maintain the durability of emulsion peaks 11.16 minutes and starts to decrease with increasing content. Therefore, plantacare 2000 UP content in the formula was selected with a of 2%.

![Figure 5](image1.png)

**Figure 5.** The effect of P2000 UP and PEG-7 on the foamability and emulsion durability.

![Figure 6](image2.png)

**Figure 6.** The effect of P2000 on the foamability and emulsion durability.

3.6. Effect of Repoly 100 thickener

About bonded evaluate, repoly 100 is satisfactory, but it does not reach the desired viscosity value. Therefore, to improve viscosity and ensure product appearance, the next survey will combine repoly 100 and NaCl.

After selecting repoly 100 as a thickener, conducting a survey on the content of repoly 100 shows that 4% has foamability 0.583 and foam durability 0.558.
Therefore, we chose repoly 100 and NaCl to conduct a detailed survey on the content used. The result of foaming of repoly 100 at 4% has the highest foamability 0.583 and foam durability 0.558, along with the highest emulsion time at 10.25 minutes at 4% compared to other patterns are shown in figure 7. After optimizing the repoly content of 100, continuing to investigate the content of NaCl agent, the result is the best foaming level of 0.583, and the best emulsifying time reaches 10.25 minutes at the of 5%.

![Figure 7. The effect of Repoly 100 on the foamability and emulsion durability.](image)

### 3.7. Evaluate product properties

Through the assessment results, it can be seen that coconut oil body wash products do not have much difference compared to lifebuoy body wash samples on the market. The Body wash is a kind of wash-away product, it does not stay on the skin for too long, so the pH value ranges quite wide from 5 to 10. For the research, body washes (pH 8.26) because the soap is the leading detergent, so the pH value will range from 8 to 10 to ensure the best soap dish to wash away. Therefore, it can be predicted that the Lifebuoy body washes with lauric acid content need to adjust to high pH value, which will show good cleaning ability. The foam durability of the product above does not change significantly compared to the foaming level, after 30 minutes, the foam volume decreases significantly.

| Parameter                      | Coconut oil body wash             | Market sample          |
|--------------------------------|-----------------------------------|------------------------|
| Appearance                     | White, pearl luster product background | White, pearl luster product background |
| pH                             | 8.26                              | 9.32                   |
| Viscosity (P)                  | >11                               | >11                    |
| Foamability                    | 0.537                             | 0.444                  |
| Foam durability (after 30 min)  | 0.519                             | 0.392                  |
| Sensory                        | Small foam, smooth                 | Small foam, smooth     |

### 3.8. Assess the possibility of market penetration

According to the results of figure 8, Hazeline and St. Ives are appreciated, and the level of popularity is outstanding, and the foamability of St. Ives is the most popular. Although not as superior as the two products above. The of the topic also has a positive effect from the user. The structure and feel on the
two products’ skin are well evaluated, but limited to the foaming. Figure 8 shows the average result of Hazeline and St. body wash. Ives is a high-end product, so it scored a high rating around 4/5. Lifebuoy and Safeguard body wash belong to the mid-range product, the price is not high, so it has a lower score. Although it is a cheap product for research body wash products, the effectiveness is quite positive, according to the user. Therefore, research body wash products are competitive and penetrate the market for cleaning products.

![Figure 8. Evaluate senses of body wash users.](image)

4. Conclusion
The crude soap mixture is created by the saponification reaction with the nature of liquid soap, has good detergency, and is suitable to add to the product formula as the detergent to replace a detergent commercial washing, reducing the amount of synthetic detergent. The ingredients in the formula’s ingredients are investigated at different levels and select the appropriate content to add to the product. Foamability and foam durability are set targets to examine the influence of ingredients in the formula. The formula of 20% crude soap and 5% SLES, combined with auxiliary detergents, moisturizers, thickeners was suitable to apply for body wash formulation.

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