Development and evaluation of shampoo products based on coconut oil source from Ben Tre Province (Vietnam)

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Abstract In order to enhance the use of coconut oil through its application in personal care products, shampoos formulated with simple soap act as the leading detergent with a 20% content and ingredients other commercial components such as Sodium Lauryl Ether Sulfate, Plantacare 2000, Glycerin, Cocamidopropyl Betaine, etc. A combination of 20% crude soap and a synthetic active substance synthesizing sodium lauryl ether sulfate (SLES) 5% make up the excellent shampoo recipe with cleansing feature. Ingredients of complementary detergents, moisturizers, and smoothing softeners are supplemented with appropriate levels to improve raw soap’s disadvantages. Foamability and foam durability are selected targets to examine the influence of ingredients in the formula. The sensory elements of the product reach the set goals with an average evaluation score of about 4/5. Thereby, shampoo products penetrate the cosmetic market and attract many consumers in the future.

1. Introduction

Today, hair care products are expected to provide additional benefits such as hair beauty or damage care. In addition to basic hair care formulas, there are select products to treat hair problems like dandruff. A large part of the hair care market is focused on products which include hair styling, coloring, and products that change the natural properties of hair fibers. Hair is an essential factor in the outside of the individual. Hair is easily damaged by weather, chemicals, heat, and abrasion; Therefore, suitable products should be used to achieve the best results. Therefore, hair care products are also essential some hair care products such as hair dyes, hair curlers, sprays, shampoos, and conditioners.

On the market today there, are many different types of shampoos, but the composition is mainly synthetic surfactants, so products of natural origin are the tastes of consumers [1]–[5]. Products with
The creation of shampoo products with ingredients of natural origin is a trend in the understanding and help of the cosmetic market. The research and development of such products include the use of coconut oil, which has good effects on the human body, especially skin and hair. Coconut oil is a lot of manufacturers’ interest and research and development of creating cleaning products with good cleaning power, safe and gentle, taking advantage of the inherent benefits of this material will be studied. The application of coconut oil into a variety of products will give more insight into the development potential of coconut oil in the field of cosmetics, thereby widely developing in the cosmetic market. The effect of coconut oil has been studied before, but the scope of application is quite limited, and the product is not diverse. Currently, coconut oil is researched and widely used in many fields such as food, cosmetics, pharmaceuticals, and other industries depending on the composition and properties of coconut oil. In cosmetics, coconut oil is used in skin and hair care, showing the ability to treat dandruff very well and help hair soft, firm. Besides, coconut oil can be used instead of moisturizers, preventing dry skin, effective acne and skin infection, excellent anti-aging, helps healthy, smooth skin. Lip balm and sunscreen products from coconut oil have been developed widely to improve the effectiveness of coconut oil and diversify the range of personal care products [9]–[11].

Coconut oil contains approximately 92.1% saturated fatty acids, 6.2% monounsaturated fatty acids, and 1.6% polyunsaturated fatty acids [12]. Coconut oil can kill bacteria thanks to the presence of monolaurin. Coconut oil has been studied and used as a lotion, safe, and effective in moisturizing the skin thanks to the effect of monolaurin [13]. Z. Ahmad and colleagues have shown coconut oil can induce fibroblast growth and proliferation to enhance wound healing. The optimal concentration of coconut oil obtained in the study was 1.0 mg/mL for the best wound healing of about 56.89 ± 2.35% after 24 hours. Research results show that coconut oil is a potential source of raw materials and has been researched and developed in many different applications.

Therefore, based on the inherited results of the research team, from the source of coconut oil material will be made saponification and leading the main detergent in the formula. Besides, focus on completing the procedure of shampoo products, researching on adding active additives to the product. Conduct analysis, evaluate the activity of the products (bonded properties; physical properties; sensory properties when used), and assess the durability of the products (tracking the product parameters when stored in normal conditions and condition of accelerated aging). Therefore, the implementation of research topics related to coconut oil will expand the understanding and help to exploit better the uses and medicinal properties of local coconut oil.

2. Material and methods

2.1. Raw materials and chemicals

Virgin Coconut Oil is produced from an all-natural raw material and an international-standard production process, by VietCoCo products of Luong Quoi Coconut Processing Co., Ltd, Chau Thanh District, Ben Tre Province (Vietnam). For the primary raw material, coconut oil is tested, identified, and evaluated the oil-specific parameters such as the saponification index, iodine index, peroxide index, and so on.

The chemicals used: Detergents, foaming agents, humectants, thickeners and Sodium Hydroxide (NaOH), etc. are purchased at Nguyen Bu Trading Production Co., Ltd, Tan Binh District, Ho Chi Minh City.
2.2. Saponification process
The saponification reaction is the reaction between oil (triglycerides) and alkali (KOH, NaOH) to form glycerol and salts of fatty acids (soaps). The saponification reaction plays an essential role in the cleansing effect of the product because the properties of the raw soap are affected by the reaction process. Based on the previous research of the authors, the optimal conditions for conducting the saponification reaction to create liquid soap are by examining parameters such as temperature 80°C, the reaction time of 3 hours, oil ratio coconut/alkali and proper alkali concentration of 11%.

2.3. The process of mixing of face wash
Mixing stage: Select the appropriate soap content and add additives to the system to complete the product’s features. Additives may need to be added: auxiliary cleaners (Sodium Lauryl Ether Sulfate), emollients (Glycerin), foam enhancers (Cocamidopropyl Betaine), thickeners (Repoly 100).

Finishing the product: Sensory additives such as color, aroma is added to increase the aesthetics of the product, can use natural flavor and color to enhance the properties of the product. The finished product will be checked and evaluated the appearance and sensory parameters when used.

2.4. The method to assess the bonded properties of products
The state of the product: the product is contained in a transparent jar and visually observed on a white background under light D65 created by VERTILUX 200 projection chamber to assess the uniformity and transparency.

Color: visual observation, color identification, and uniformity for preliminary evaluation. If accurate determination is required, a colorimetric method may be carried out using a colorimeter. Odor: describes the perceived odor.

2.5. 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 times 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: \( \varepsilon_f = \frac{V_{foam} - V_{liquid}}{V_{foam}} \), with: \( \varepsilon_f \): foamability; \( V_{foam} \): foam volume after shaking; and \( V_{liquid} \): initial liquid volume.

3. Result and discussion
The formulation of shampoo products will be based on the shower gel surveyed by the authors, with the effect of simple soap, SLES, glycerin, auxiliary cleaners, foaming agents, and thickeners. However, the surface of skin and hair is not the same, so the amount of moisturizing and softening hair will affect the sensory use. Therefore, next only the sensory survey is used on the hair and is assessed on a scale of 1 to 5.

3.1. Effect of crude soap
Simple soap is the leading detergent in the formula. However, it needs to be combined with a part of commercial detergent to increase the cleaning effect and the sensory use. The results in figure 1 show the apparent change in foam when changing the crude soap content. Based on foaming and foam resistance, samples containing 20% dry soap content reached the highest values with 0.612 and 0.569. In terms of emulsifying time, there is the longest separation time under the influence of paraffin oil (11.18 minutes) and tends to decrease when increasing the content from 20%–50%.
Figure 1. The effect of crude soap on foamability and emulsion durability.

3.2. Effect of Sodium Lauryl Ether Sulfate (SLES) detergent
Crude soap for large foam systems reduces sensory and make a dry skin sensation. Therefore, the need to add synthetic surfactants to create a better sense of use. The surfactant used is SLES; the effect of the agent and detergent content on the foamability and emulsion of the durability of the shampoo is shown in figure 2. The best concentration at 5% with the longest time of 12.05 minutes. Respectively, the foaming and foam resistance is 0.612, and the foam strength is 0.55.

Figure 2. The effect of SLES on foamability and emulsion durability.

3.3. Effect of glycerin humectants
Because the raw soap initially contains glycerin and is not separated from the mixture. It can be predicted that the change in glycerin content affects the foam properties of the product. Therefore, glycerin content was investigated from 1 to 5%. Therefore, to ensure the ability to cleanse, and moisturize the skin after use, glycerin is selected for the 3% content to be the highest with 0.580 foamings and 0.558 foam resistance.
Figure 3. The effect of Glycerin on foamability and emulsion durability.

3.4. Effect of Cocamidopropyl Betaine (CAPB) foaming agent
CAPB helps to foam and stabilize the foam while thickening the product and reducing skin irritation. CAPB content was surveyed from 0 to 10%. The survey results are shown in figure 4. The highest foamability at 5% CAPB content with 0.593 foamings and 0.573 foam strength. However, at 5% content with a stable time of 11.32 minutes, there was not much difference compared to other content, so combined with the ability to foamability, the CAPB content was selected as 5%.

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

3.5. Effect of P2000 UP and PEG-7 auxiliary cleaners
Adjuvant cleaners added to plantacare 2000 UP and PEG-7 were selected for the survey. The result is shown in figure 5, with a total of detergents being 5% (without the combination of PEG-7).
Specifically, when adding 2% of the plantacare 2000 substance, the product shows the best cleaning ability (foaming capacity 0.6, foam resistance 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 content of 2%.
3.6. **Effect of Repoly 100 thickener**

Visually, only 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 incorporate Repoly 100 and NaCl’s addition.

The result of foaming of repoly 100 at 4% has the highest foamability (0.583) and foam strength (0.558), along with the durability of the emulsion at 10.25 minutes at 4% content compared to other Other patterns are shown in figure 7.

3.7. **Effect of hair smooth**

In addition to moisturizing the skin, polyquaternium-7 also has a hair-softening effect and is useful when used in combination with other emollients. Therefore, polyquaternium-7 was investigated at concentrations from 0 to 5%. The evaluation results are shown in figure 8.

With substance content from 0 to 5%, the change of evaluation point is shown in figure 8. Products, when not using polyquaternium-7, feels dry and fibrous hair. But when increasing the content to 1%, the efficiency of use changed significantly and reached the maximum rating. The similar results were
shown from 2 to 4%. At 5% content, when used, it creates a greasy, unclean feeling. Therefore, selecting polyquaternium-7 1% content added to the formula to investigate the next factor.

![Graph](image1)

**Figure 7.** The effect of Repoly 100 on foamability and emulsion durability.

![Graph](image2)

**Figure 8.** The effect of polyquaternium-7 content on sensory use of shampoo.

### 3.8. Effect of hair softener

The ingredients of serashine 301-A are the active ingredients that soften hair, and the small amount of this ingredient in the product formula also significantly changes the effectiveness of use. Therefore, the content of serashine 301-A added to the formula does not exceed 3%. The evaluation results are shown in figure 9.

From the results of figure 9, when adding silicone with the content improved from 1 to 3%, the evaluation score increased from 1 to 3. When adding 0.5% serashine 301-A, the highest evaluation score creates a sense of using the best. Therefore, it can be seen with a small amount of silicone, forming a surface layer that covers and softens hair. Therefore, serashine 301-A content is selected at 0.5% to add to the product.
Figure 9. The effect of 301-A content on sensory use of shampoo.

Table 1. Basic specifications of shampoo products.

| Parameter                | Coconut oil shampoo                      | Market sample                      |
|--------------------------|------------------------------------------|-----------------------------------|
| Appearance               | White, pearl luster product background   | Light blue, opaque product background |
| pH                       | 8.24                                     | 6.68                               |
| Viscosity (P)            | >11                                      | >11                                |
| Foamability              | 0.485                                    | 0.412                              |
| Foam durability (after 30 min) | 0.462                                    | 0.355                              |
| Sensory                  | Small foam, smooth                       | Big foam, lots, dry hair           |

Figure 10. Evaluate senses of body wash users.
The evaluation results show that coconut oil shampoo products are not much different from the shampoo samples on the market. In terms of pH value, the main product is raw soap, so it needs to adjust the pH in the range of 8 to 10. Specifically, study shampoos have pH 8.24, and market shampoos have pH 6.68, both products meet the pH value requirements. Similarly, with a product viscosity > 11 P, the foaming properties and foam strength meet the original standards. In terms of foamability and foam durability in both products, there is no significant difference.

The result in figure 10 shows the higher the product rating, the further away it is from the center. Therefore, shampoo products in clear and opaque formulations have shown quite satisfactory results.

The rating in figure 10 has a clear difference between the surveyed products, Sunsilk and Rejoice shampoos have a relatively high rating of about 4/5. Lifebuoy, Double Rich and Clear shampoos scored lower, especially Clear, which made the hair feel dry and fibrous, so it had the lowest rating (3 points). With an average score higher than some market products after performing user reviews, the average score of 3.7 researched shampoo products is competitive and penetrates the cleaning products market.

4. Conclusion
From the survey of market products and the introduction of target parameters, the research product aims to have a dry matter content of about 20–35%, a pH value of 8–10, meeting the criteria for ability detergency as well as durability and have an average sensory evaluation score above 3.67. Products after the survey used 20% simple soap combined with other detergents such as Sodium Lauryl Ether Sulfate, Plantacare 2000, besides Cocamidopropyl Betaine, moisturizers, soft skin, and some other substances. To form the complete recipe. After that, the product is checked for appearance and basic parameters products meet the requirements. Although parameters of dry matter content, pH, foam volume, etc. have changed but not significantly, they still met the initial target requirements.

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