THE RESEARCH ON THE FORMULATION PROCESS FOR REPAIRING NATURAL SKIN USING COCONUT OIL AND EXTRACT OF HOUTTUYNIA CORDATA LEAVES TO SUPPORT SKIN CLEANSING AND ACNE PREVENTION

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Abstract - Facial cleansing maintains skin health, but many commercial cleansers use synthetic surfactants that may irritate or dry sensitive skin. Natural alternatives are therefore desirable. A natural facial cleanser was formulated using Houttuynia cordata extract (HCe) and coconut oil, two locally sourced ingredients in Vietnam. HCe, rich in flavonoids and polyphenols, was extracted and tested for antibacterial activity at 8% (v/v) against Staphylococcus aureus. Coconut oil, abundant in saturated fatty acids, was included for moisturization and skin barrier reinforcement. Carbomer 940 was used to optimize viscosity and texture. HCe at 8% produced an inhibition zone of 8 mm against S. aureus. The cleanser formulation maintained stable pH, satisfactory viscosity, and structural integrity over three weeks, while retaining antibacterial activity. The HCe–coconut oil formulation demonstrated effective cleansing and antimicrobial properties, suggesting its potential as a promising natural alternative to conventional facial cleansers.

Key words - Coconut oil; *Houttuynia Cordata;* cleanser; antibacterial; cosmetics formulation

1. Introduction

Skin care is an essential aspect of maintaining both the health and aesthetic appearance of the human body, particularly in the context of the increasing prevalence of acne vulgaris. Acne not only affects physical appearance but can also lead to psychological stress, particularly among adolescents and young adults. While a wide range of treatments for acne exist, there is growing interest in utilizing natural, safe, and effective alternatives. Among these alternatives, coconut oil (*Cocos nucifera*) and *Houttuynia cordata*, commonly known as fish mint or houttuynia, have gained attention for their potential in skincare, particularly for acne prevention and skin cleansing. Recent studies have provided substantial evidence supporting the dermatological benefits of both coconut oil and *H.cordata*.

Coconut oil (CO) is widely recognized for its moisturizing, antimicrobial, and wound – healing properties[1], [2]. Composed primarily of saturated medium chain fatty acids (lauric acid, caprilic acid,…) and essential vitamins such as A and E, CO not only nourishes the skin but also supports the prevention and treatment of acne. Numerous studies have demonstrated that CO possesses natural antimicrobial activity, capable of inhibiting the growth of acne – causing bacteria, while also reducing inflammation [3]. A study by Abel Anzaku et al. demonstrated that coconut oil, due to its high lauric acid content, possesses significant anti – inflammatory and antimicrobial properties [4], [5]. This ability to combat the bacteria associated with acne, such as *Propionibacterium acnes*, combined with its skin-moisturizing effects, makes it an effective natural solution for managing acne [6]. Additionally, its ability to maintain skin hydration enhances the skin's barrier function, providing protection against environmental stressors that can contribute to acne formation. On the other hand, *H.cordata* has been traditionally used in Asian medicine due to its anti-inflammatory, antimicrobial, and antioxidant properties [7] Phytochemicals such as flavonoids and alkaloids in *H.cordata* have been shown to promote wound healing, reduce skin inflammation, and enhance cellular regeneration [8]. Several flavonoids and polyphenols found in *H.cordata* have been reported to exhibit strong antibacterial and anti-inflammatory activities that are relevant to acne treatment [10]. Notably, quercetin, quercitrin, and hyperoside are among the key flavonoids identified in *H.cordata*, and they have demonstrated significant inhibition of pro-inflammatory cytokines such as TNF-α and IL-6 [9]. These compounds are also known to modulate inflammatory signaling pathways, including NF-κB and MAPK [11]. The essential oil and ethanol extracts of *H. cordata* have shown antimicrobial effects against acne-related bacteria, particularly *Staphylococcus aureus*, through disruption of bacterial membranes and inhibition of growth. Consequently, *H.cordata* has been found to be an effective remedy for acne and other inflammatory skin conditions [12]. While the individual benefits of coconut oil and *H.cordata* have been well-documented, there is a lack of comprehensive studies exploring the synergistic effects of these two ingredients in a single formulation for acne prevention and skin cleansing. This strategic combination allows for both antibacterial and anti-inflammatory action within one formulation, offering a promising and differentiated approach to acne management compared to previously reported herbal combinations [13]

Therefore, this study aims to develop a formulation combining coconut oil and *H.cordata* extract to enhance the efficacy of skin cleansing and acne prevention, providing a sustainable and safe solution for skincare.

Especially, Vietnam is one of the largest producers of coconuts in the world, and *H.cordata* is a widely available herb in the country. Despite the abundance of these natural resources, their potential applications in the skincare and cosmetic industries remain underexplored. The utilization of such readily available ingredients not only offers an opportunity to innovate in the field of natural skincare but also has the potential to create significant economic value. By developing formulations that incorporate coconut oil and *H.cordata*, this research aims to harness the potential of these abundant local resources, contributing to the growth of Vietnam's GDP and promoting sustainable development. This approach aligns with the country's objectives of enhancing the value of domestic raw materials and advancing eco – friendly industries in a sustainable manner.

The research focuses on:

1. Assessment the antibacterial properties of the *H.cordata* extract on *Staphylococcus aureus (S.aureus)*.

2. Developing a stable facial cleanser formulation, including assessment the ratio of Carbomer 940 on product texture and their stability.

3. Evaluation the key quality parameters of cleanser such as texture stability, pH stability, cleansing ability and antibacterial efficacy.

The results of this study are expected to contribute to high – quality skincare product development, enhance the economic value of coconut oil and native botanical resources, and promote the growth of Vietnam's natural cosmetics industry.

2. Materials and methods

2.1. Materials

H.cordata leaves were purchased directly from a local market in Da Nang, Vietnam. Virgin coconut oil (Vietcoco) was supplied by Luong Quoi Coconut Co., Ltd. (Ben Tre province, Vietnam). The bacterial strain *Staphylococcus aureus (S.aureus*) was isolated, cultured, and preserved at the Biotechnology Laboratory, The University of Danang - University of Science and Technology.

Chemical agents: Ethanol 95% (India), Polyethylene Glycol, PEG-7 and PEG-20 (Germany), Glyceryl Stearate (India), Sodium Benzoate (China), Carbomer 940 0.25% (China), Triethanolamine 98% (China), Dimethyl Sulfoxide (China), Muller-Hinton Broth (Himedia, India).

2.2. Preparation of bioactive extract from H.cordata

The biologically active extract of *H.cordata* was obtained following the extraction process described in the study by the authors from Huaiyin University, Putian, China [14], with modifications, as follows. The leaves of *H.cordata* were washed, dried at 60°C for 5 hours, and ground to a size of 2.0 – 2.5 mm. Then, ethanol 95% was added at a ratio of 1: 16 (w/v) and soaked for 5 minutes. The mixture was then subjected to ultrasonic extraction (300 W, 37 kHz), with extraction times of 240 minutes at 60°C. The extract was collected by vacuum filtration and rotary evaporated at 60°C. The resulting extract of *H.cordata* was recovered and stored.

2.3. Preparation of facial cleanser from coconut oil with H. cordata extract

Based on the emulsion formulation of oil/water (O/W) [15], the procedure for producing a facial cleanser from coconut oil with *H.cordata* extract was modified as outlined in the following process with components listed in Table 1.

Table 1. *Formulation of a coconut oil-based facial cleanser supplemented with H.cordata extract*

Phase	%w/w input	Ingredient
A	70	Coconut oil
A	4	PEG – 20
A	2,5	PEG – 7
A	1	Glyceryl stearate
B	13	Distilled water
B	0.5 – 1.5	Carbomer 940
B	0.5	Sodium benzoate
C	8	*H.cordata* extract
	q.s.	Triethanolamine TAE

– Phase A: Oil phase components (emulsifiers and base oil), heated and mixed for emulsification.

– Phase B: Aqueous phase (water – soluble ingredients, preservatives, thickener).

– Phase C: Bioactive phase (*H.cordata* extract), added post-emulsification to preserve activity.

Methods include several steps:

1. Mix Phase A and heat to 70 – 80°C while stirring at 400 – 600 rpm for 10 minutes until homogeneous.

2. Separately heat Phase B to 70 – 80°C, stirring at 400 – 600 rpm for 10 minutes until well mixed.

3. Slowly add Phase A into Phase B at 4-5 mL/min while maintaining 70 – 75°C. Stir at 1000-1200 rpm to form a stable emulsion, then continue stirring at 70 – 80°C at 400 – 600 rpm.

4. Introduce Phase C at 40°C, mix, and stabilize at 30 – 40°C.

5. Homogenize using a vortex mixer, then package in sterilized containers.

2.4. Sensory evaluation

To assess the gel or liquid formulations with different ratios of *Carbomer 940*, we conducted a sensory evaluation to examine the product's homogeneity, phase separation, viscosity, and overall suitability. The gel samples were prepared with different *Carbomer 940* concentrations (0.5%, 1.0%, 1.5% w/w) and thoroughly mixed before evaluation. First, the homogeneity of the product was checked by visual observation and tactile assessment of its texture and color. Then, phase separation of the samples was monitored over a period of 2-3 hours after preparation, recording any separation if present. For the gel formulations, viscosity and flow were assessed by direct tactile evaluation and a viscosity meter, and the feel on the

skin was also noted. The products were classified as "suitable" or "not suitable" based on their ability to maintain homogeneity, prevent phase separation, and exhibit an appropriate viscosity for the intended formulation

2.5. Determination of antibacterial activity

Antibacterial activity was assessed using the agar diffusion method. The study used the gram – positive bacterial strain *S.aureus*, cultured from the Biotechnology department, the university of Danang. First, a bacterial suspension was prepared by dissolving the bacterial culture in Mueller-Hinton Broth (MHB) to achieve a bacterial concentration of 10^6 CFU/mL. Different test samples were added to the corresponding wells on the agar plate, including: negative control (10% DMSO), positive control (Ampicillin 10 µg/mL), and samples of *H.cordata* extract at concentrations of 100% and 8% (v/v). Each well received 100 µL of the respective solution and was left at room temperature for 2 hours on a flat surface to ensure proper diffusion. The agar plates were then incubated at 37°C for 24 hours before evaluating the results [16]

The antibacterial activity was determined by measuring the diameter of the inhibition zone using the formula:

$$Inhibitory\ zone\ (mm) = D - d$$

Where D: the diameter of the inhibition zone, d: the diameter of the agar hole.

2.6. Determination of product texture stability

After homogenizing the oil and water phases to form a homogeneous yellow – green gel mixture, it was packaged in opaque white tubes, sealed, and stored at room temperature, avoiding direct sunlight. Along with testing for cleansing ability and irritation, the product's structural stability was observed to check if any phase separation occurred.

2.7. Determination of pH stability

1g of facial cleanser was dissolved in 10 mL of distilled water, and the pH was measured using pH meter. The experiment was repeated three times, and the results were averaged.

2.8. Determination of cleansing and irritation ability

To evaluate the cleansing ability of the facial cleanser, a preliminary test was conducted focusing on its effectiveness in removing waterproof mascara. Since in vitro testing has not yet been performed, the evaluation was carried out in vivo on the hand skin of healthy volunteers. A standardized amount of waterproof mascara was applied to the skin and allowed to dry. The test product was then applied directly over the mascara and gently massaged for 30 seconds, following the principle of a short-contact patch test. After the contact period, the area was rinsed with water. Cleansing efficacy was assessed visually by determining whether the mascara was completely removed. Skin irritation was monitored by observing any visible skin reactions such as redness, swelling, or itching immediately and up to 24 hours post-application.

2.9. Experiment analysis

The variability degree of results was expressed in the form of means ± standard deviation (mean ± SD) based on triplicate determinations (n = 3 for replicate plates). The data were statistically analyzed by one-way ANOVA analysis and compared using the least significant difference (LSD) test at $p < 0.001$(***).

3. Result analysis

3.1. Effect of H.cordata extract concentration on the antibacterial activity against S. aureus

To evaluate the antibacterial efficacy of the *H.cordata* extract, the extract was diluted 8% (v/v) by dissolving it in 10% DMSO. The samples were then used to test the inhibition of *S.aureus* using the agar well diffusion method. The positive control (Ampicillin) resulted in a well-defined inhibition zone, validating the experimental conditions, whereas the negative control (DMSO) showed no inhibition, confirming that the antimicrobial activity originated solely from the extract. As shown in Figure 1, both the 100% whole extract and the 8% diluted extract produced clear inhibition zones around the wells, indicating antimicrobial effects.

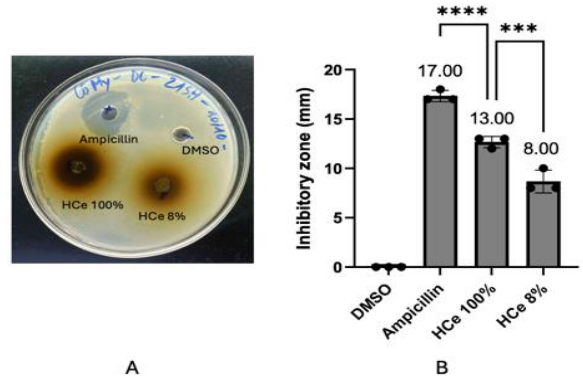


Figure 1. *Antimicrobial activity of Houttuynia cordata whole extract (HCe 100%) and 8% v/v in DMSO (HCe 8%)against S. aureus in one experiment (A) and Summary graph based on three replicates (B). Positive control: Ampicillin; negative control: DMSO*

The whole extract exhibited a strong inhibitory effect with an average inhibition zone diameter of approximately 13mm, while the 8% concentration produced a smaller with inhibition zone of about 8mm. These results suggest that while the antimicrobial effect of the 8% extract is less potent than the undiluted version, it remains effective at inhibiting *S.aureus*. However, the determining the Minimum Inhibitory Concentration (MIC) is essential to help identify the most effective yet economical concentration to inhibit bacterial growth while minimizing the amount of extract used. Given that the goal of a gentle facial cleanser is to inhibit bacterial growth rather than completely eliminate bacteria, it is crucial to preserve the beneficial bacteria on the skin. Complete eradication of bacteria could disrupt the skin's natural microbiome and harm beneficial microorganisms that contribute to skin health.

In conclusion, the 8% concentration seems to be the most suitable choice for formulating a cost – effective,

antibacterial facial cleanser, making it the selected concentration for synthesizing the facial cleanser in this study.

3.2. Effect of the ratio of Carbomer 940 on product texture

In the formulation of the facial cleanser, the ratio of thickening agents is crucial. This study used Carbomer 940 as a thickening agent for *H.cordata* extract to formulate the water phase of the product. Carbomer 940, a high molecular weight polyacrylic acid polymer, is widely used in cosmetic formulations due to its exceptional ability to thicken, stabilize, and enhance the texture of various cosmetic products. One of the key advantages of Carbomer 940 is its high efficiency in viscosity control, which helps in achieving stable emulsions and preventing phase separation in formulations. The ease of use, combined with its ability to maintain long – term stability and resist changes in pH, makes Carbomer 940 a preferred choice in the formulation of high – performance and consumer – friendly cosmetic products.

Table 2. *Sensory evaluation and stability of the product based on Carbomer 940 ratios*

Ratio Carbomer 940 to product (w/w)	Sensory evaluation	Conclusion
0.5	The product is homogeneous in liquid form. Phase separation occurs after 2-3hours	Not suitable
1.0	The product is homogeneous in gel form. No phase separation occurs after 2-3hours	Suitable
1.5	The product is homogeneous in super – thick gel form, with minimal flow. No phase separation occurs after 2-3hours	Not suitable

The ratios of Carbomer 940 to product (w/w percentage) were studied, and the product structure was compared visually to select the most appropriate ratio for the product (from 0.5% to 1.5%) by the sensory evaluation describing in section 2.2.2 and presented in Table 2. At 0.5%, the facial cleanser exhibited a loose texture and a non – homogeneous structure, which was observed to be unstable after storage with signs of phase separation. This indicated a lack of necessary cohesion or stability for long – term use. When the concentration increased to 1%, the product reached an optimal texture, and the emulsion system became more homogeneous without any signs of aggregation or phase separation. Furthermore, the product's sensory qualities improved, resulting in a smoother texture and ease of application. The product has a stable gel structure that does not separate after storage. This suggests it has the necessary cohesion and stability, similar to other products on the market. At 1.5%, although the the texture continued to thicken, making it difficult to dispense and spread on the skin. While the product does not separate, its excessively thick and low – flow gel nature may not be suitable for intended use, as this could make it difficult to apply or unsuitable for certain applications.

From the results obtained, the optimal Carbomer 940 concentration was determined to be 1%, as it helps maintain the stability of the emulsion structure, provides a pleasant feeling during use, and ensures suitable physicochemical properties for the coconut oil – based facial cleanser with added *H. cordata* extract.

3.3. Evaluation of parameters for product stability

3.3.1. Texture stability

Measuring texture stability is crucial for ensuring product quality and user experience. Characteristics like thickness, softness, smoothness, and adhesiveness influence consumer perception and product performance over time. Maintaining stability prevents issues such as phase separation, clumping, or viscosity changes under environmental stress.

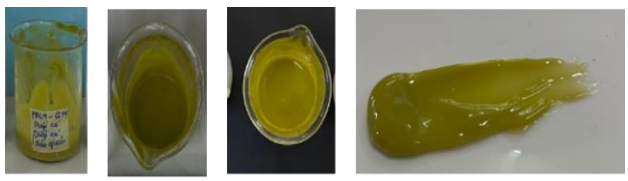


Figure 2. *Stability evaluation of facial cleanser formulations at different storage times. (A) Day 0, (B) Day 1, (C) Day 7, (D) Day 14. Formulations were stored at room temperature and visually monitored for phase separation, color, and consistency changes*

The product's structural stability was monitored over two weeks. At day 0 (Figure 2A), it exhibited a homogeneous structure without phase separation. After one day (Figure 2B) and one week (Figure 2C), no changes in color, texture, or consistency were observed, indicating strong stability. At day 14 (Figure 2D), tactile and visual assessments confirmed that the product maintained its gel – like texture, low viscosity, greenish color, slight stickiness, and quick – drying properties. No sedimentation or significant texture changes occurred throughout the period, confirming the product's high stability. Further sensory evaluations with broader sample sets, also long-term stability studies (3 – 6 months) or accelerated stability testing under harsh conditions are recommended to refine product quality and align with market expectations.

3.3.2. pH stability

Skin care products for sensitive acne – prone skin typically need to have a pH range of 4.5 to 5.5, because a pH that is too high or too low can cause irritation, damage the skin's natural barrier, and worsen acne conditions. A product with unstable pH can disrupt the skin's environment, interrupting the natural skin regeneration process and increasing the risk of inflammation or irritation. Therefore, controlling and maintaining pH stability in skin care products is crucial to ensure that the product is both safe and effective in supporting the treatment of acne and improving the skin's condition. The pH of the product was monitored over a period of 2 weeks. The results of the measurements are recorded in Table 3.

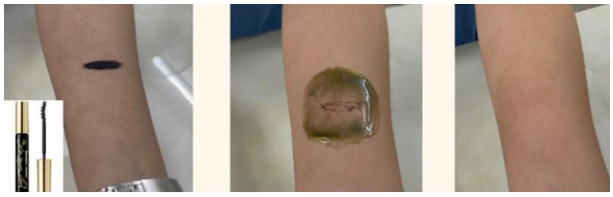
Table 3. *Results of pH testing at different time points*

Day	pH
D_0	5.5
D_1	5.4
D_3	5.5
D_5	5.5
D_7	5.5
D_{14}	5.4

Based on Table 3, the pH of the product remained consistently within the range of 5.4 – 5.5 throughout the testing period, indicating that the product has good pH stability, does not cause irritation, and is suitable for the skin's natural pH. To ensure a more accurate assessment of the product's long – term stability, it is recommended to extend the testing period for pH stability and structural stability, which can be evaluated through oxidation (referencing sources), up to 6 months. This will help ensure that the product maintains its quality and safety during storage and use.

3.3.3. Cleansing ability

Since the product is intended for facial cleansing, including makeup removal, particularly mascara, a test was conducted on the hand skin that had been made up with mascara.



A B C

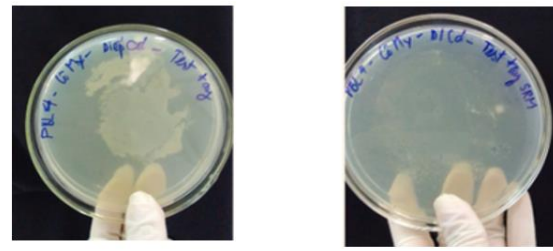
Figure 3. *Evaluation of the facial cleanser's ability to remove mascara from the skin. A: Skin with applied mascara. B: Application and gentle massage of the cleanser. C: Skin after cleansing, showing complete removal of mascara*

The results in Figure 3 showed that the facial cleanser effectively removed mascara without the need for vigorous rubbing. The mascara was completely removed, leaving no residue, and the skin did not feel greasy or dry after washing. While the cleanser demonstrated preliminary potential in cleansing efficacy, further comprehensive studies are necessary-particularly irritation and toxicity testing-to ensure its safe application in sensitive areas such as around the eyes.

3.3.4. Antibacterial ability

This antibacterial test was conducted to address the lack of scientific validation for the antibacterial claims made by many commercial facial cleansers. While these products often advertise antibacterial properties, few actually conduct tests to confirm their efficacy. In this study, we tested the facial cleanser with *H.cordata* extract on the hands, as the product is still in the experimental phase and not yet tested on facial skin.

The results in Figure 4 showed a significant difference: the commercial product left bacterial clusters, indicating bacterial persistence, while the test product showed no bacterial growth, confirming its strong antibacterial efficacy. This indicates that the antibacterial properties of the *Houttuynia cordata* extract are preserved in the product, helping to significantly reduce the bacterial count on the skin. These promising initial results suggest the cleanser effectively reduces bacterial presence on the skin. Moving forward, further development will focus on assessing potential irritation, especially considering that the product is intended for sensitive, acne – prone skin.



A B

Figure 4. *Evaluation of the antibacterial effect of the facial cleanser containing Houttuynia cordata extract on hand skin before (A) and after (B) applying the cleanser*

4. Conclusion

This research highlights the promising outcomes of a facial cleanser formulated using two abundant local ingredients in Vietnam: *Houttuynia cordata* extract and coconut oil. The product demonstrated visible antibacterial activity and cleansing effectiveness, while maintaining stable pH and texture over a three-week observation period. These results suggest its potential as a natural skincare solution.

However, as this is an early-stage formulation, further long-term studies are required to assess the product's structural stability and sustained antibacterial efficacy. Future research should also aim to determine the minimum inhibitory concentration (MIC) of the *H. cordata* extract, as well as evaluate potential skin irritation through in vitro models. Progressing to ex vivo, in vivo, and eventually clinical testing will be essential to fully validate the safety and efficacy of the formulation under real-life dermatological conditions.

While this study also aimed to highlight the lack of scientific validation in antibacterial claims made by many commercial cleansers, no control comparison was conducted. Including commercial facial cleansers in future experiments-tested under identical conditions-would provide a more objective benchmark and help contextualize the product's antibacterial performance in the current market.

In addition to its antibacterial potential, *H. cordata* is well-documented for its anti-inflammatory and antioxidant activities, attributed to bioactive compounds such as polyphenols and flavonoids. These compounds may enhance skin barrier function and aid in preventing acne and inflammation. Further investigation into these properties could expand the product's potential as an anti-inflammatory and anti-aging skincare solution.

Finally, the use of locally available ingredients not only

provides economic and accessibility advantages but also aligns with sustainability goals. This approach supports the growing demand for safe, natural, and environmentally friendly cosmetic products, contributing to the sustainable development of the cosmetic industry.

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