Borneo Journal of Pharmacy
Vol 8 Issue 2 May 2025
Pages 158 – 166

https://journal.umpr.ac.id/index.php/bjop/article/view/5800
DOI: https://doi.org/10.33084/bjop.v8i2.5800
e-ISSN: 2621-4814

Research Article

Natural Self-Foaming Clay Soap with *Etlingera elatior* Fruit Extract for Skincare

Vica Aspadiah [1*]
Wa Ode Sitti Zubaydah [1]
Astrid Indalifiany [1]
Sahidin [1]
Adryan Fristiohady [1,2]
Muhammad Hajrul Malaka [1]
Rahmat Muliadi [1]
Arsyani Parrung [1]

[1] Department of Pharmacy, Universitas Halu Oleo, Kendari, Southeast Sulawesi, Indonesia
[2] Postdoctoral Fellowship, Thammasat University, Bangkok, Bangkok Metropolitan Administration, Thailand

*email: vicaaspadiah@uho.ac.id; phone: +628114101234

Keywords:
Antioxidant
Cosmetics
Etlingera elatior
Self Foaming Clay Soap

Abstract

Etlingera elatior (Wualae), a plant recognized for its flavonoid-derived antioxidant properties, presents a potential source for cosmeceutical applications. This study investigated the formulation and evaluation of a Self-Foaming Clay Soap (SFCS) incorporating an ethanol extract of *E. elatior* fruit. The SFCS base, comprising surfactant as a cleansing and foaming agent combined with bentonite clay for enhanced serviceability and oil adsorption, was formulated with varying concentrations of bentonite (0%, 5%, 10%, 15%, and 20% w/w), designated as FI to FV, respectively, alongside other necessary excipients. The resulting SFCS preparations underwent rigorous physical and chemical stability assessments following accelerated storage conditions (freeze-thaw cycles). Evaluated parameters included organoleptic properties, foam stability and height, viscosity, dispersibility, homogeneity, and pH. The evaluation revealed that Formulation II (FII), containing 5% w/w bentonite, exhibited the most favorable stability profile and met the established criteria for SFCS semisolid preparations. Specifically, FII demonstrated a foam stabilization rate of 84.61% and a foam height of 2.6 cm after freeze-thaw cycling, a viscosity of 10,000 cPs, a spreadability diameter of 4.1 cm, a homogeneous texture devoid of coarse particles, and a skin-compatible pH of 5. These findings suggest that an SFCS formulation incorporating a 5% w/w concentration of bentonite and *E. elatior* fruit extract holds promising potential as a stable and efficacious skincare preparation.

Received: September 19th, 2023
1st Revised: May 21st, 2024
2nd Revised: April 22nd, 2025
3rd Revised: May 8th, 2025
Accepted: May 19th, 2025
Published: May 30th, 2025

INTRODUCTION

Indonesia's tropical climate exposes its population to intense solar radiation throughout the year, rendering individuals particularly susceptible to premature skin aging induced by ultraviolet (UV) light[1]. Skin aging is broadly categorized into intrinsic aging, which is chronologically driven, and extrinsic aging, primarily caused by environmental factors like UV exposure. Beyond UV-induced damage, the tropical climate can also destabilize sebaceous gland secretion, leading to imbalanced sebum production and predisposing the skin to various concerns[2].

Addressing these skin issues often involves topical treatments such as facial cleansers. While activated charcoal and clay are effective cleansing agents, activated charcoal is often cost-prohibitive. Conversely, clay, a more affordable and abundantly available product of granite rock weathering, offers an economical alternative[3]. Clays with a two-layer structure (inner and outer layers) exhibit superior adsorption capabilities compared to single-layered clays, making them more effective for deep cleansing[4].

How to cite: Aspadiah V, Zubaydah WOS, Indalifiany A, Sahidin, Fristiohady A, Malaka MH, et al. Piper cubeba L. f. Natural Self-Foaming Clay Soap with Etlingera elatior Fruit Extract for Skincare. Borneo J Pharm. 2025;8(2):158-66. doi:10.33084/bjop.v8i2.5800

Another significant health concern exacerbated by tropical climates is premature skin aging, largely driven by the formation of Reactive Oxygen Species (ROS) due to UV radiation. This imbalance between endogenous antioxidants and free radicals accelerates skin aging, manifesting as wrinkles and fine lines. Antioxidants combat this by donating electrons to oxidant compounds, thereby inhibiting oxidative damage and preserving skin integrity[5].

Given their abundant antioxidant content, plant-derived compounds offer a promising alternative to synthetic options in both oral supplements and topical skincare products. Natural antioxidants are generally favored due to their reduced side effect profiles[6]. An example is the wualae (*Etlingera elatior* (Jack) R. M. Smith) fruit from the Zingiberaceae family, traditionally used by the Tolaki people of Southeast Sulawesi as a culinary spice and empirical medicine[7]. The ethanolic extract of *E. elatior* fruit exhibits potent antioxidant activity, primarily attributed to its flavonoid and polyphenol content, which can readily donate hydrogen atoms to counteract oxidant compounds[8]. Furthermore, flavonoids also possess moisturizing properties, helping to maintain skin hydration, regulate oil production, and prevent xerosis[9]. Despite the widespread inclusion of antioxidants in commercial facial cleansers, synthetic variants like butylated hydroxy toluene (BHT) and butylated hydroxy anisol (BHA) have raised concerns due to their potential long-term carcinogenic effects[10]. This has spurred a growing demand among manufacturers for natural antioxidant alternatives.

Facial cleansers are diverse, with formulations tailored to specific skin types; for instance, oil-free products are recommended for oily skin[11]. Common types include foaming cleansers, gel cleansers, milk cleansers, cleansing creams, lotions, and wipe cleansers[12]. Foaming cleansers, known for their smooth, foamy texture, effectively remove dirt and impurities by forming an emulsion with water, reaching deep into facial pores. The primary cleaning action and foam generation are facilitated by amphiphilic surfactants[13].

Research into Self-Foaming Clay Soap (SFCS) incorporating *E. elatior* fruit extract as a facial cleanser remains limited. While *E. elatior* fruit extract is recognized for its bioactive compounds, including flavonoids and polyphenols, which confer antibacterial activity against acne-causing bacteria and antioxidant properties against free radical-induced skin damage[14], the specific potential of the fruit within a self-foaming, clay-based facial cleanser formulation has not been extensively explored. Moreover, there is a notable gap in research concerning the formulation development and stability of such cosmetic preparations. Therefore, this study aims to develop and formulate a SFCS enriched with ethanol extract of *E. elatior* fruit as a natural active ingredient for facial skincare. The evaluation will focus on the physical characteristics and stability of the formulation to ascertain the potential of *E. elatior* fruit extract in enhancing the performance of clay-based facial cleansers.

MATERIALS AND METHODS

Materials

Etlingera elatior fruit was collected from Batu Putih District, North Kolaka Regency, Southeast Sulawesi. The determination process was conducted at the Laboratory of the Department of Biology Education, Faculty of Teacher Training and Education, Universitas Halu Oleo with the official registration number 03/BIO/PB/II/2021. All chemicals and reagents were of analytical grade. Specifically, the ingredients used in this study included 96% ethanol, distilled water, bentonite clay, cocamidopropyl betaine, disodium EDTA, glycerin, methylparaben, lavender essential oil, sodium lauryl sulfate, and Nesco® universal pH paper. The study utilized standard laboratory equipment, including various glassware, Pyrex beakers and test tubes, a glass stirrer, a dropper pipette, a rotary evaporator, an oven, a Stuart CB 162 stirrer, spatulas, a stopwatch, vials, a Rhion VT-04 viscometer, a Bio-Rad BR 200 vortex mixer, and a water bath.

Methods

Sample preparation

Etlingera elatior fruit samples were collected and immediately subjected to wet sorting to separate fresh from non-fresh fruit. The selected fresh fruits were then thoroughly washed under running water, followed by chopping into smaller pieces. These prepared pieces were then dried using air drying in the shade. After drying, a dry sorting process was conducted to remove any remaining impurities or substandard material. Finally, the dried and sorted *E. elatior* fruit was ground into a fine simplicia powder using a blender.

Extraction

The simplicia powder was subjected to maceration for extract preparation. Specifically, 4 kg of the dried simplicia powder was steeped in 10 L of 96% ethanol for three consecutive 24-hour periods. Following maceration, the mixture was filtered through a funnel equipped with filter paper to separate the liquid filtrate from the solid residue. The resulting filtrate was then concentrated using a rotary evaporator set at 50°C with a rotation speed of 3, reducing the volume by approximately one-third. Further concentration of this reduced filtrate was achieved by heating it over a water bath at 40°C until a viscous, thick extract was obtained.

Formulation of SFCS

The SFCS containing *E. elatior* fruit ethanol extract was prepared in a total batch size of 100 g. The specific composition of the formula is detailed in **Table I**. All raw materials were accurately weighed as per the formulation design. The preparation began by dissolving xanthan gum in 20 mL of distilled water, followed by the addition of glycerin. This mixture was then heated on a hotplate at 55–65°C for 30 minutes, with continuous stirring, until a homogeneous batch was formed. Subsequently, disodium EDTA, pre-dissolved in 2 mL of distilled water, was incorporated into the mixture. Stirring continued until homogeneity was achieved, with the temperature reduced to 45–55°C to prevent excessive heat from decreasing the xanthan gum's viscosity.

Next, bentonite, pre-hydrated with 5 mL of distilled water, was gradually added to the batch while homogenizing with a magnetic stirrer until a smooth consistency was obtained. The batch was then cooled to 28–30°C. Following this, sodium lauryl sulfate (SLS), previously dissolved in 2 mL of distilled water, and cocamidopropyl betaine (CAPB) were added and slowly stirred until homogeneous. Methylparaben, pre-dissolved in 2 mL of 96% ethanol, was then introduced with gentle stirring. The *E. elatior* fruit ethanol extract, also pre-dissolved in 96% ethanol, was subsequently added, and the mixture was homogenized again. Finally, distilled water was added to achieve a total preparation weight of 100 g, and flavoring was incorporated, with the batch stirred until a uniform formulation was attained[15].

Table I. SFCS formula design of ethanol extract of *E. elatior* fruit.

Materials	Concentration (%)				
	F1	F2	F3	F4	F5
Etlingera elatior fruit extract	15	15	15	15	15
Bentonite	0	5	10	15	20
Glycerine	10	10	10	10	10
SLS	2	2	2	2	2
CAPB	2	2	2	2	2
Disodium EDTA	0.2	0.2	0.2	0.2	0.2
Methylparaben	0.1	0.1	0.1	0.1	0.1
Xanthan gum	1.5	1.5	1.5	1.5	1.5
Lavender oil	0.001	0.001	0.001	0.001	0.001
Distilled water	ad 100	ad 100	ad 100	ad 100	ad 100

Evaluation of SFCS

Organoleptic test: Organoleptic properties of the prepared formulations were assessed visually, both before and after the freeze-thaw stability test. This evaluation involved meticulously observing and recording changes in the color, odor, and physical form/texture of the preparations. The primary criterion for a stable formulation in this evaluation was the absence of any perceivable changes in these organoleptic parameters[16].

Stability and foam height: Briefly, 1 g of the test preparation was accurately weighed and transferred into a test tube containing 10 mL of distilled water. The mixture was then vortexed for 1 minute to generate foam. Immediately after shaking, the initial foam height was measured using a ruler. To determine foam stability, the foam height was measured again after a 5-minute interval (final foam height). Foam stability was then calculated based on these measurements, as previously described[17].

Viscosity test: The viscosity of the prepared formulations was assessed using a Rhion VT-04 viscometer. For each evaluation, the test preparation was carefully loaded into the viscometer cup, and spindle number 2 was attached. Viscosity was determined by observing the movement of the viscometer point[18], which directly correlates to the internal resistance of the fluid. Consistent with standards for semisolid preparations, the acceptable viscosity range for foaming cleanser formulations is between 4,000 and 40,000 cPs[19].

Spreadability: The spreadability of the prepared formulations was assessed by applying a 0.5 g sample of the test preparation between two glass plates. A 50 g weight was then carefully placed on the upper plate for 1 minute. The resulting diameter of the spread sample was measured. Additional 50 g loads were incrementally applied, and the diameter was recorded after each addition until a constant diameter was achieved. Optimal spreadability, indicative of a well-dispersed formulation, is typically defined as a diameter ranging from 3 to 5 cm[20].

Homogeneity test: The homogeneity of the preparation was assessed by spreading a small amount of the formulation onto a transparent glass surface. The sample was then visually inspected for the absence of any discernible particles or aggregates[21].

pH test: Briefly, 1 g of the preparation was accurately weighed and then dissolved in 10 mL of distilled water. A universal pH indicator stick was subsequently immersed into the solution, and the resulting color change was compared against the standard color chart provided with the indicator to ascertain the pH value[22].

Cooling-heating test: The stability of the formulations under accelerated storage conditions was evaluated using a freeze-thaw method. Test preparations, contained in tightly sealed beakers, were subjected to alternating temperature cycles: 24 hours at 40°C (hot temperature) followed by 24 hours at 4°C (cold temperature). This cycle was repeated for a total of six cycles to simulate accelerated aging. Throughout and after these cycles, the physical stability of the formulations was comprehensively assessed. This evaluation included observing changes in organoleptic properties, measuring foam stability and height, determining viscosity, evaluating spreadability, assessing homogeneity, and monitoring pH levels.

Data analysis

The evaluation data from the SFCS preparations were rigorously compared against the established physicochemical requirements for semi-solid foaming cleansers. This systematic comparison aimed to identify the optimal formulation that consistently fulfilled all predetermined physical and chemical evaluation criteria, ensuring product quality and efficacy.

RESULTS AND DISCUSSION

A total of 20 kg of fresh *E. elatior* fruits were processed to obtain 4 kg of dried simplicia powder. Subsequent extraction of this powder yielded 271.6 g of thick *E. elatior* fruit extract, corresponding to an extraction yield of 6.8%. The SFCS preparation was successfully formulated using a straightforward mixing method, yielding five distinct formulations as detailed in **Figure 1**. The selection and concentration of excipients significantly influenced the physicochemical characteristics of these preparations. For instance, xanthan gum, employed as a thickening agent, directly correlated with increased viscosity. This rise in viscosity is attributed to the formation of hydrogen bonds between xanthan gum and water molecules, leading to larger molecular aggregates that impede flow. Furthermore, xanthan gum plays a crucial role in preventing syneresis within the preparation[23]. Similarly, the inclusion of SLS, a common ingredient in facial cleansing products, contributed to increased viscosity, particularly when combined with hydrophilic thickening agents like gums, cellulose, or acrylic acid derivatives[24].

a **b** **c** **d** **e**

Figure 1. SFCS formula with variation of concentration of ethanol extract of *E. elatior* fruit at: (**a**) F1: 0%; (**b**) F2: 5%; (**c**) F3: 10%; (**d**) F4: 15%; and (**e**) F5: 20%.

Beyond thickening agents, the humectant glycerin also impacted the viscosity of the SFCS preparations. Glycerin's hygroscopic nature and high affinity for water molecules enable it to bind and retain moisture, thereby increasing the

effective size of molecular units. This, in turn, enhances the preparation's resistance to flow and spread, resulting in a more viscous consistency[25]. These observations collectively highlight the critical role of excipient selection in tailoring the desired physical properties of SFCS formulations.

The physical characteristics of the SFCS preparations containing *E. elatior* fruit ethanol extract was visually assessed through organoleptic tests. Notably, F1 exhibited a distinct white color, differentiating it from the remaining formulations, which presented a brown hue. The detailed results of these observations are presented in **Table II**.

Table II. Organoleptic test of SFCS preparation of ethanol extract of *E. elatior* fruit before and after cooling-heating.

Formula	Texture		Color		Scent	
	Before	After	Before	After	Before	After
F1	Soft	Soft	White	White	Lavender	Lavender
F2	Soft	Soft	Brown	Brown	Lavender	Lavender
F3	Soft	Soft	Brown	Brown	Lavender	Lavender
F4	Soft	Soft	Brown	Brown	Lavender	Lavender
F5	Soft	Soft	Brown	Brown	Lavender	Lavender

Evaluation of foam stability and height is a crucial parameter, particularly for formulations incorporating foaming agents like surfactants, as it indicates the preparation's ability to maintain gas bubbles over a specified test duration[26]. The results, summarized in **Table III**, showed a consistent decrease in foam height across all formulas, ranging from 0.8 to 0.3 cm. This reduction in foam stability is likely influenced by temperature fluctuations during storage, which can lead to ingredient degradation[27]. Interestingly, variations in bentonite concentration within the liquid soap formulation did not significantly affect the foam's stability or height[28]. This is supported by the relatively small decrease in stability observed in F1, which contained no bentonite, suggesting other factors are more influential.

Table III. Evaluation of the stability and height of SFCS foam before and after cooling-heating.

Formula	Foam height (cm)		Foam stability (%)	
	Before	After	Before	After
F1	4.2	3.7	87.5	84.44
F2	3.3	2.6	84.61	78.78
F3	3.1	2.3	83.78	76.66
F4	2.2	1.9	81.48	73.07
F5	1.9	1.3	76	68.42

Viscosity measurements of the SFCS preparations, incorporating varying bentonite concentrations, are depicted in **Figure 2**. A notable increase in viscosity was observed across all formulations after cooling-heating cycles. This phenomenon is attributed to water evaporation from the preparation due to alternating temperature changes and desorption processes[29], leading to a higher concentration of the remaining components.

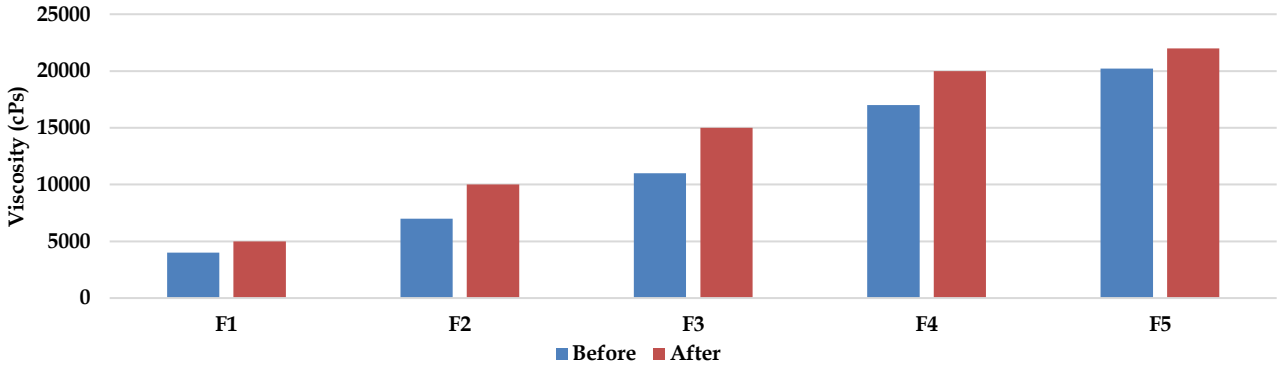

Figure 2. Viscosity of SFCS ethanol extract of *E. elatior* fruit before and after cooling-heating.

The spreadability of the five formulations was evaluated, with results presented in **Figure 3**. The data indicated that the spreadability of the *E. elatior* fruit ethanol extract SFCS preparations decreased as the bentonite concentration increased. This is because higher bentonite concentrations necessitate a reduction in the volume of aqua dest to maintain the total

preparation weight, resulting in a thicker consistency. Similarly, the cooling-heating treatment led to a decrease in dispersibility, consistent with the observed increase in viscosity.

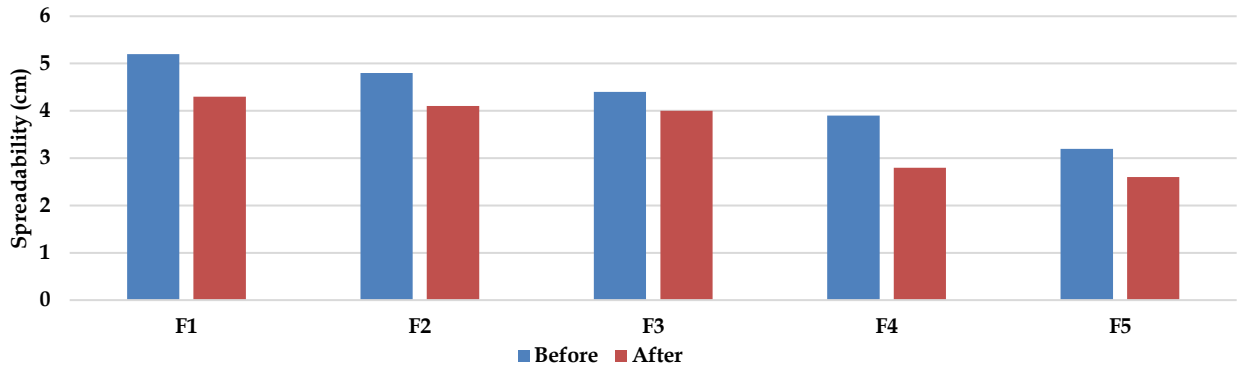

Figure 3. Spreadability of SFCS ethanol extract of *E. elatior* fruit before and after cooling-heating.

Finally, homogeneity tests, as shown in **Table IV**, confirmed uniform distribution across all SFCS formulations. pH measurements, presented in **Figure 4**, revealed that neither an increase in bentonite concentration nor exposure to six cooling-heating cycles altered the pH value of the *E. elatior* fruit ethanol extract SFCS preparations. The pH remained stable at approximately 5, both before and after the stability tests. While bentonite is known for its alkaline pH (ranging from 9-10.5 according to Rowe *et al.*[30]), its presence did not significantly shift the overall pH of the SFCS preparations. This suggests that the acidic to neutral pH range (4.0-7.0) of other excipients, such as disodium EDTA, CAPB, methylparaben, xanthan gum, and glycerin (excluding SLS which has a pH of 7.0-8.5), effectively buffered the alkaline influence of bentonite, maintaining the preparation's acidic pH.

Table IV. Evaluation of the homogeneity of SFCS foam before and after cooling-heating.

Formula	Homogeneity	
	Before	After
F1	Homogen	Homogen
F2	Homogen	Homogen
F3	Homogen	Homogen
F4	Homogen	Homogen
F5	Homogen	Homogen

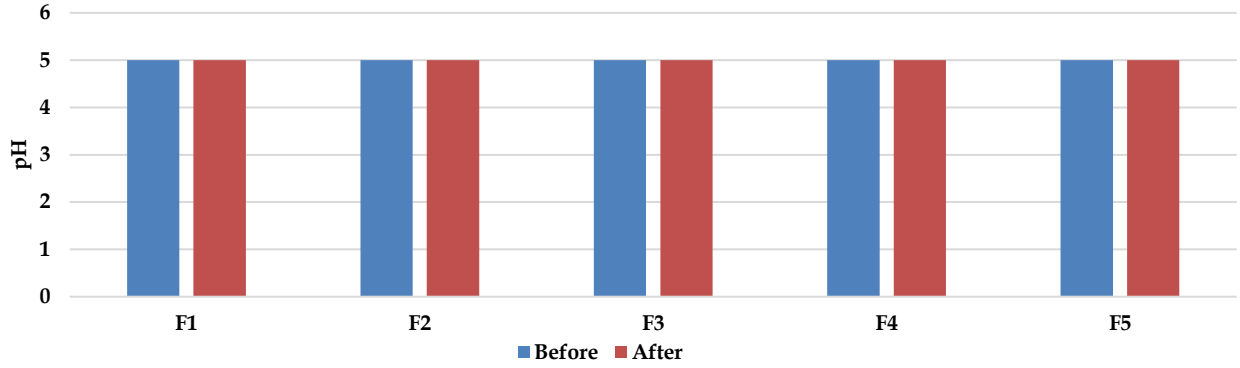

Figure 4. pH of SFCS ethanol extract of *E. elatior* fruit before and after cooling-heating.

CONCLUSION

This study successfully developed a SFCS formulation incorporating the ethanol extract of Etlingera elatior fruit using a mixing technique. The optimized formulation comprised bentonite as an adsorbent, SLS and CAPB as foaming agents, glycerin as a humectant, methylparaben as a preservative, disodium EDTA as a chelating agent, and lavender essential oil for fragrance. Among the five SFCS formulations evaluated for physical and chemical stability, F2 was identified as the most

suitable. This optimal formulation met the criteria for a semi-solid SFCS preparation, exhibiting a robust foam stability of 84.61% and foam height of 2.6 cm after heating-cooling cycles, a viscosity of 10,000 cPs, a dispersion diameter of 4.1 cm, excellent homogeneity, and a pH of 5.0. These characteristics collectively affirm F2's potential as an effective and stable topical semi-solid cleanser.

ACKNOWLEDGMENT

The authors extend their sincere gratitude to all individuals who contributed to the successful completion of this research. Their invaluable insights, technical assistance, and unwavering support were instrumental in achieving the objectives of this study.

AUTHORS' CONTRIBUTION

Conceptualization: Vica Aspadiah, Wa Ode Sitti Zubaydah, Astrid Indalifiany, Sahidin, Adryan Fristiohady, Rahmat Muliadi, Arsyani Parrung
Data curation: Vica Aspadiah, Wa Ode Sitti Zubaydah, Astrid Indalifiany, Rahmat Muliadi, Arsyani Parrung
Formal analysis: Vica Aspadiah, Wa Ode Sitti Zubaydah
Funding acquisition: -
Investigation: Vica Aspadiah, Astrid Indalifiany, Rahmat Muliadi, Arsyani Parrung
Methodology: Vica Aspadiah, Wa Ode Sitti Zubaydah, Astrid Indalifiany, Rahmat Muliadi, Arsyani Parrung
Project administration: Vica Aspadiah, Wa Ode Sitti Zubaydah, Astrid Indalifiany
Resources: Vica Aspadiah, Wa Ode Sitti Zubaydah, Astrid Indalifiany, Rahmat Muliadi, Arsyani Parrung
Software: -
Supervision: Sahidin, Adryan Fristiohady
Validation: Vica Aspadiah, Wa Ode Sitti Zubaydah, Astrid Indalifiany, Rahmat Muliadi, Arsyani Parrung
Visualization: Vica Aspadiah, Wa Ode Sitti Zubaydah, Astrid Indalifiany, Rahmat Muliadi, Arsyani Parrung
Writing - original draft: Vica Aspadiah, Wa Ode Sitti Zubaydah, Astrid Indalifiany, Sahidin, Adryan Fristiohady, Rahmat Muliadi, Arsyani Parrung
Writing - review & editing: Vica Aspadiah, Wa Ode Sitti Zubaydah, Rahmat Muliadi

DATA AVAILABILITY

None.

CONFLICT OF INTEREST

The authors declare no conflicts of interest related to this study.

REFERENCES

1. Mayangsari E, Mustika A, Nurdiana N, Samad NA. Comparison of UVA vs UVB Photoaging Rat Models in Short-term Exposure. Med Arch. 2024;78(2):88-91. DOI: 10.5455/medarh.2024.78.88-91; PMCID: PMC10983087; PMID: 38566862

2. Wong QYA, Chew FT. Defining skin aging and its risk factors: a systematic review and meta-analysis. Sci Rep. 2021;11(1):22075. DOI: 10.1038/s41598-021-01573-z; PMCID: PMC8586245; PMID: 34764376

3. Ihekweme GO, Shondo JN, Orisekeh KI, Kalu-Uka GM, Nwuzor IC, Onwualu AP. Characterization of certain Nigerian clay minerals for water purification and other industrial applications. Heliyon. 2020;6(4):e03783. DOI: 10.1016/j.heliyon.2020.e03783; PMCID: PMC7182682; PMID: 32346634

4. Otunola BO, Ololade OO. A review on the application of clay minerals as heavy metal adsorbents for remediation purposes. 2020;18:100692. DOI: 10.1016/j.eti.2020.100692

5. Pizzino G, Irrera N, Cucinotta M, Pallio G, Mannino F, Arcoraci V, et al. Oxidative Stress: Harms and Benefits for Human Health. Oxid Med Cell Longev. 2017;2017:8416763. DOI: 10.1155/2017/8416763; PMCID: PMC5551541; PMID: 28819546

6. Maury GL, Rodríguez DM, Hendrix S, Arranz JCE, Boix YF, Pacheco AO, et al. Antioxidants in Plants: A Valorization Potential Emphasizing the Need for the Conservation of Plant Biodiversity in Cuba. Antioxidants. 2020;9(11):1048. DOI: 10.3390/antiox9111048; PMCID: PMC7693031; PMID: 33121046

7. Leorita M, Mardikasari SA, Wahyuni, Malaka MH, Sartinah A, Sahidin. Aktivitas Antioksidan dan Toksisitas Akut Ekstrak Etanol Buah, Daun, Batang dan Rimpang Tanaman Wualae (Etlingera elatior (Jack) R.M. Smith). Pharmauho. 2018;4(2):36–9. DOI: 10.33772/pharmauho.v4i2.6263

8. Jabbar A, Wahyuni, Malaka MH, Apriliani. Aktivitas Antioksidan Ekstrak Etanol Buah, Daun, Batang Dan Rimpang Pada Tanaman Wualae (Etlingera Elatior (Jack) RM Smith). J Farmasi Galenika Galenika J Pharm. 2019;5(2):189–97. DOI: 10.22487/j24428744.2019.v5.i2.13671

9. Zawawi NA, Ahmad H, Madatheri R, Fadilah NIM, Maarof M, Fauzi MB. Flavonoids as Natural Anti-Inflammatory Agents in the Atopic Dermatitis Treatment. Pharmaceutics. 2025;17(2):261. DOI: 10.3390/pharmaceutics17020261; PMCID: PMC11859288; PMID: 40006628

10. Khan MK, Paniwnyk L, Hassan S. Polyphenols as Natural Antioxidants: Sources, Extraction and Applications in Food, Cosmetics and Drugs. In: Li Y, Chemat F, Editors. Plant Based "Green Chemistry 2.0". Singapore: Springer; 2019. p. 197-235. DOI: 10.1007/978-981-13-3810-6_8

11. Mijaljica D, Spada F, Harrison IP. Skin Cleansing without or with Compromise: Soaps and Syndets. Molecules. 2022;27(6):2010. DOI: 10.3390/molecules27062010; PMCID: PMC8954092; PMID: 35335373

12. Mukhopadhyay P. Cleansers and their role in various dermatological disorders. Indian J Dermatol. 2011;56(1):2-6. DOI: 10.4103/0019-5154.77542; PMCID: PMC3088928; PMID: 21572782

13. Ananthapadmanabhan KP, Moore DJ, Subramanyan K, Misra M, Meyer F. Cleansing without compromise: the impact of cleansers on the skin barrier and the technology of mild cleansing. Dermatol Ther. 2004;17(Suppl 1):16-25. DOI: 10.1111/j.1396-0296.2004.04s1002.x; PMID: 14728695

14. Safrina U, Wardiyah, Cartika H. Evaluation of total flavonoid, total phenolic, and antioxidant activity of Etlingera elatior (Jack) RM Sm flower, fruit, and leaf. Majalah Obat Trad. 2022;27(1):51–9. DOI: 10.22146/mot.72210

15. Tazberik E, Shah S, inventors. Neutrogena LLC, assignee. Foaming clay cleanser composition. Canadian Patent CA2431529A1. 2003-12-10.

16. Leal GC, da Costa IM, da Silva JB, dos Santos RS, Bruschi ML, de Mello JCP, et al. Development, characterization, and evaluation by cutaneous bioengineering of a natural emulsion, to provide a standardized vehicle base for topical compounded preparations. Res Soc Dev. 2022;11(16):e509111638290. DOI: 10.33448/rsd-v11i16.38290

17. Goon P, Bhirud RG, Kumar VV. Detergency and foam studies on linear alkylbenzene sulfonate and secondary alkyl sulfonate. J Surfact Deterg. 1999;2:489–93. DOI: 10.1007/s11743-999-0097-0

18. Pryazhnikov MI, Yakimov AS, Denisov IA, Pryazhnikov AI, Minakov AV, Belobrov PI. Fluid Viscosity Measurement by Means of Secondary Flow in a Curved Channel. Micromachines. 2022;13(9):1452. DOI: 10.3390/mi13091452; PMCID: PMC9502554; PMID: 36144075

19. Garg A, Aggarwal D, Garg S, Singla AK. Spreading of Semisolid Formulations: An Update. Pharm Technol. 2002;26(9):84-105.

20. Syaman HP, Unnikrishnan BS, Sreekutty J, Archana MG, Preethi GU, Reshma PL, et al. Polysaccharide-capped silver nanoparticles impregnated cream for the efficient management of wound healing. RSC Pharm. 2025;2(3):570-80. DOI: 10.1039/d4pm00274a

21. Alam P, Imran M, Jahan S, Akhtar A, Hasan Z. Formulation and Characterization of Hesperidin-Loaded Transethosomal Gel for Dermal Delivery to Enhance Antibacterial Activity: Comprehension of In Vitro, Ex Vivo, and Dermatokinetic Analysis. Gels. 2023;9(10):791. DOI: 10.3390/gels9100791; PMCID: PMC10606654; PMID: 37888364

22. Bartram J, Balance R, editors. Water quality monitoring: a practical guide to the design and implementation of freshwater quality studies and monitoring programmes. London: Chapman and Hall; 1996.

23. Krystyjan M, Dobosz-Kobędza A, Sikora M, Baranowska HM. Influence of Xanthan Gum Addition on the Short- and Long-Term Retrogradation of Corn Starches of Various Amylose Content. Polymers. 2022;14(3):452. DOI: 10.3390/polym14030452; PMCID: PMC8839150; PMID: 35160442

24. Benalaya I, Alves G, Lopes J, Silva LR. A Review of Natural Polysaccharides: Sources, Characteristics, Properties, Food, and Pharmaceutical Applications. Int J Mol Sci. 2024;25(2):1322. DOI: 10.3390/ijms25021322; PMCID: PMC10816883; PMID: 38279323

25. Misra A, Shahiwala A, editors. Applications of Polymers in Drug Delivery. 2nd edition. Amsterdam: Elsevier; 2021.

26. Kamal MS. A Novel Approach to Stabilize Foam Using Fluorinated Surfactants. Energies. 2019;12(6):1163. DOI: 10.3390/en12061163

27. Nova JF, Smrity SZ, Hasan M, Tariquzzaman M, Hossain MAA, Islam MT, et al. Comprehensive evaluation of physico-chemical, antioxidant, and antimicrobial properties in commercial soaps: A study on bar soaps and liquid hand wash. Heliyon. 2025;11(4):e41614. DOI: 10.1016/j.heliyon.2024.e41614; PMCID: PMC11867263; PMID: 40028542

28. Pratama CM, Desmayanti A, Marchaban, Rohman A. Optimization of Liquid Soap Containing Bentonite and Combination of Corn Oil and Virgin Coconut Oil for Cleansing Najs Mughalladzah. J Food Pharm Sci. 2020;8(1):184-92. DOI: 10.22146/jfps.640

29. Kumar A, Patham B, Mohanty S, Nayak SK. Polyolefinic nanocomposite foams: Review of microstructure-property relationships, applications, and processing considerations. J Cell Plast. 2020;58(1):59-102. DOI: 10.1177/0021955X20979752

30. Rowe RC, Sheskey PJ, Quinn ME. Handbook of Pharmaceutical Excipients. 6th edition. London; Pharmaceutical Press; 2009.