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Research Article

Formulation and Physical Stability Evaluation of Sacha Inchi (Plukenetia volubilis L.) Oil-Based Body Lotion as Skin Moisturizer

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Abstract

Background: Sacha Inchi oil (*Plukenetia volubilis* L.) is rich in essential fatty acids and antioxidants, making it a promising active ingredient in body lotion formulations for skin moisturization and protection.
Aims and Scope: This study aimed to evaluate the effect of varying concentrations of Sacha Inchi oil on the physical stability, moisturizing effectiveness, and user acceptability of body lotion formulations.
Methods: Three body lotion formulas were prepared with Sacha Inchi oil at concentrations of 5% (F1), 6% (F2), and 7% (F3). Evaluations included organoleptic observations, pH measurement, viscosity, spreadability, moisturizing effectiveness using a skin analyzer, irritation tests, and hedonic tests involving 20 panelists.
Result: Formula F3 demonstrated the best moisturizing effectiveness, increasing skin moisture by 20.45%, with a pH of 6.45, viscosity of 6,150 cP, and spreadability of 5.4 cm. Although F3 had the highest moisturizing effect, F2 was the most preferred by panelists, with 83.3% indicating strong preference for texture and 72.2% for spreadability. All formulas showed no signs of irritation.
Conclusion: The body lotion containing 7% Sacha Inchi oil (F3) was the most effective in enhancing skin moisture, while the 6% formulation (F2) was the most favorable in terms of sensory attributes.

Keywords: Body lotion; Physical stability; Sacha inchi; Skin moisture

1. INTRODUCTION

The cosmetics and skincare industry continues to evolve as awareness of the importance of skin health and aesthetics increases (Juvita Herdianty, 2023). In general, cosmetics are applied directly to the external surfaces of the human body with four primary purposes: (1) to maintain optimal condition; (2) to enhance or alter appearance; (3) to provide protection; and (4) to control or mask body odor (Wikantyasning & Wahyuni, 2024).

As the baby boomer generation reaches older age, the aspiration to maintain a healthier and more youthful appearance has driven significant market demand and opened global opportunities. The influence of social media and the internet has heightened public awareness about the potential risks of chemical ingredients in

Consequently, the cosmetic industry is increasingly cosmetics, as well as the health advantages of plant-based and other naturally sourced products. focusing on the development and use of natural products (Alves et al., 2020).

One type of skincare cosmetic is lotion, a liquid emulsion composed of an oil phase and a water phase stabilized by an emulsifier. It serves to protect the skin and help maintain its moisture levels (Iskandar et al., 2021).

Inca peanut (*Plukenetia volubilis* L.) is a perennial oil-bearing plant belonging to the Euphorbiaceae family. It thrives in the Amazon region of South America, covering areas of Peru and northwestern Brazil, where conditions include adequate water availability and well-drained acidic soils (Gonzalez-Aspajo et al., 2015).

The seeds have been employed for oil extraction due to proven benefits supported by various studies. In recent years, interest has increased in cultivating the Inca peanut as a new source of oil abundant in unsaturated fatty acids (Chandrasekaran & Liu, 2015)

Sacha inchi oil (Plukenetia volubilis L.) contains linoleic acid or ω6 (45.72%), linolenic acid or ω3 (42.27%), palmitic acid (6.42%) and stearic acid (4.53%) (Wuttisin, 2017). It also comprises essential amino acids, including cysteine, tyrosine, threonine, and tryptophan, along with vitamin E, polyphenols, and minerals (Wang et al., 2018).

Sacha inchi oil is incorporated into lotions to deliver both a synergistic effect and a moisturizing benefit for

the skin. This oil-based body lotion formulation still faces challenges in physical stability and comfort of use, which affects the quality and shelf life of the product (Ravera et al., 2021).

Some of the obstacles in sacha inchi oil-based body lotion formulations include its oily nature and the tendency of the emulsion to be unstable (Badruddoza, 2023). Factors such as oil concentration, formulation pH, and mixing method are known to greatly affect the stability and homogeneity of the product (Trindade, 2024). Too high an oil concentration can impair the texture and stability of the emulsion, while inappropriate pH and suboptimal mixing can degrade the final quality. Physical stability evaluations, including organoleptic observations, pH, viscosity, and homogeneity measurements, as well as skin moisture tests, are required to ensure product quality and effectiveness during storage (Maya, 2024).

This study aims to develop a sacha inchi oil-based body lotion formulation with good physical stability and a comfortable texture to use, as well as evaluate its effectiveness in increase.

2. MATERIAL AND METHOD

2.1 Ingredients

The ingredients needed for this study are sacha inchi oil, sunflower oil, glyceryl stearate, disodium EDTA, spectrastat PHL, texique HE20, perfume, and aqua.

2.2 Equipment

The equipment used in the study included spatulas, watch glasses, spreading force test glasses, stirring rods, beaker glasses, pipettes, water baths, porcelain dishes, measuring cups, climatic chambers, viscometers (Lamy Rheology First Touch 15.04), pH meter (NeoMet pH-240L GJ-7726), homogenizer (WiseTis HG-15D), analytical balance (Adam PW254), skin analyzer (CR-302).

2.3 Procedure

2.3.1 Preparation of the formulation

Prepare the equipment and ingredients, weigh each ingredient. Mix EDTA and water in a beaker, heat to 80°C, homogenize (water phase). Mix sacha inchi oil, glyceryl stearate, and sunflower oil in another beaker, heat to 80°C, homogenize (oil phase). Mix the oil phase into the water phase, homogenize and emulsify for 10 minutes at high speed. Add Texique HE 20 and cool to 40°C, homogenize. At 40°C, add Spectrastat PHL and homogenize. Add perfume as needed, homogenize again until a perfect lotion is formed. Full details of the composition of each formula can be seen in Table 1 below.

Table 1. Formulation of Sacha Inchi Body Lotion

Name of Ingredient	Concentration (%)			Function
	F1	F2	F3	
Sacha Inchi Oil	5	6	7	Skin Conditioning
EDTA	0,1	0,1	0,1	Chelating Agent
Sunflower Oil	3	3	3	Emollient
Glyceryl Sterate	3	3	3	Surfactant
Texique HE 20	4	4	4	Thickener
Spectrastat PHL	1,5	1,5	1,5	Preservative
Parfume	0,01	0,01	0,01	Fragrance
Aqua	83,40	82,40	81,40	Solvent

2.3.2 Physical Stability Test of Lotion

The stability test was conducted at a storage temperature of 40°C with a relative humidity of 75% for 3 months using a climatic chamber. The stability test was conducted for 90 days or 3 months, which was evaluated at 0, 7, 15, 21, 30, 60, and 90 days. The physical stability test for the body lotion formulation was conducted as follows:

2.3.3 Organoleptic Test

Organoleptic testing of Sacha Inchi Body Lotion was conducted by observing the shape, color changes, and aroma of the Sacha Inchi Body Lotion formula. These observations were made on days 0, 7, 21, 15, 30, 60, and 90.

2.3.4 pH Test

The pH test on the lotion formulation is performed by taking a sample of the lotion in a small container, then immersing the pH meter electrode directly into the formulation until the reading on the screen stabilizes, and then recording the result. After measurement, the electrode is cleaned with distilled water or a special tissue to prevent lotion residue that could damage the sensor (Megantara et al., 2017). The pH requirement for lotion formulations according to SNI 16-4399-1996 (Indonesian National Standard) is 4.5–8.0. This test is conducted on days 0, 7, 15, 21, 30, 60, and 90.

2.3.5 Viscosity Measurement

Viscosity testing was conducted using a Lammy Rheology Viscometer. The sample preparation was placed in a cup, then a spindle was attached for measurement. The test was conducted by operating the rotor at a speed of 30 rpm. The viscosity range in

accordance with the SNI 16-4399-1996 standard is between 2000 and 50,000 Cp (centipoise) (Rahayu, 2016).

2.3.6 Spreadability Measurement

0.5 grams of lotion sample was placed on a 15 cm diameter round glass, another glass was placed on top of the gel and left for 1 minute. The spread diameter was measured. Then, 150 grams of additional weight is added and left for 1 minute, after which the diameter of the sample is measured. Good spreadability of the lotion is 5–7 cm. This test is conducted on days 0, 7, 15, 21, 30, 60, and 90.

2.3.7 Moisture Test

Twenty panellists were selected based on the criteria of having normal skin moisture and not using other products in the test area. Moisture measurements were taken using a skin analyser. The preparation was applied to the underside of the arm over an area of 2 x 5 cm. Before applying the lotion, skin moisture levels were first measured using the same device. Skin moisture levels were determined two minutes after application. The data obtained were classified according to the following scale: dry (0%–40%), normal or moist (41%–55%), and very moist (56%–100%) (Ningsih et al., 2021).

2.3.8 Hedonic Test

A total of 20 panellists were randomly selected to complete the questionnaire provided. Each panellist had an equal opportunity to evaluate the appearance, color, and aroma of the three lotion formulas. The evaluation was conducted using a hedonic test, which aims to assess the panellists' level of acceptance or liking of the product. The hedonic scale used ranged from 1 to 4, namely: (1) strongly dislike, (2) dislike, (3) like, and (4) strongly like (Rahayu, 2016).

2.3.9 Irritation Test

First, recruit a number of volunteers who meet the inclusion criteria, such as being between 18 and 25 years old, having normal skin without a history of allergies, and willing to participate in the entire test series. Next, clean the skin area behind each volunteer's ear using sterile cotton pads soaked in 70% alcohol to remove dirt and oil that could affect the test results. Once the area is dry, apply approximately 0.1 grams of body lotion to an area with a diameter of about 3 cm behind the ear. Leave the application uncovered and allow it to remain without washing or covering it. After this period, evaluate the application area for signs of irritation, such as redness, itching, swelling, or rash. If no signs of irritation are found in all volunteers, the body lotion can be considered safe for use. A similar procedure has been applied in previous studies, such as those conducted by Densi and Mila (2019).

2.3.10 Data Analysis

The data obtained were analyzed statistically using the One-Way ANOVA method to see significant differences between formulations, with a significance level of 95% ($p < 0.05$). If there were significant differences, a Tukey post hoc test was performed to determine the actual differences between groups. Flowchart in Figure 1.

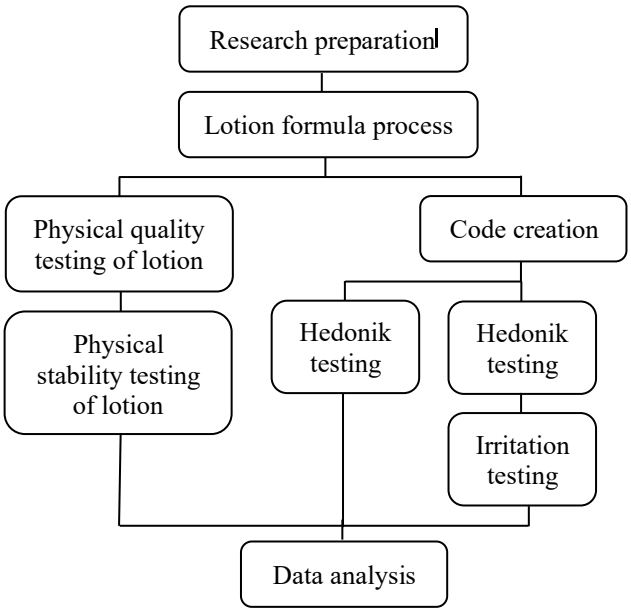

Figure 1. Research Flow Chart

3. RESULT AND DISCUSSION

3.1 Results

Preparation of sacha inchi oil includes sorting, washing, and drying the seeds at temperatures below 50°C to maintain the stability of the active compounds. The seeds were then crushed and extracted using the cold pressing method at temperatures below 40°C without solvent to maintain the essential fatty acid content. The extracted oil is filtered and refined through degumming, neutralization, bleaching, and deodorization processes to improve clarity and stability, then packaged in light- and air-tight containers to prevent degradation.

The preparation of Sacha Inchi Oil Body Lotion begins with accurate weighing of ingredients. EDTA and water were mixed in a beaker glass, then heated to 80°C with a hotplate stirrer while homogenizing to form the water phase. Separately, sacha inchi oil, glyceryl stearate, and sunflower oil were heated at the same temperature and homogenized to form the oil phase. The oil phase was then mixed into the water phase, homogenized and emulsified for 10 minutes using a homogenizer at 800 rpm. After the temperature of the mixture dropped to 40°C, texique HE20 was added and homogenized again. Next, spectrastat PHL was added at 40°C and homogenized. Perfume was added last, then the mixture was homogenized until a homogeneous lotion was formed. The total preparation produced was 300 grams, which was then divided into three lotion pots of 100 grams each.

The physical quality test of Sacha Inchi Body Lotion includes organoleptic test, pH test, viscosity test, and spreadability test. Of the three formulations made, all of them fall into the criteria for short-term stability testing as listed in Table 2 of the physical quality test results.

Table 2. Physical Quality Test Results

Testing	Criteria	Test Result		
		F1	F2	F3
Organoleptic	Thick, White colour, Fragrant	Thick, White colour, Fragrant	Thick, White colour, Fragrant	Thick, White colour, Fragrant
pH	4-8	7,78	7,84	7,90
Viscosity	2000-50.000 cps	22.890 cps	19.722 cps	18.052 cps
spreadability	5-7 cm	5,3 cm	5,3 cm	5,3 cm

The physical stability test of the sacha inchi Body Lotion preparation was carried out by storing it in accordance with BPOM regulations in 2020 at a temperature of 40 °C with a relative humidity of 75% for 3 months using a climatic chamber in the Preparation Technology Laboratory, Faculty of Pharmacy, Buana Perjuangan University, Karawang. The stability test was carried out for 90 days or 3 months, which was evaluated at 0, 7, 15, 21, 30, 60, and 90 days.

Figure 2. Physical Stability Test

Table 3. pH Test Results

pH Test Standars	F	Testing to day						
		0	7	15	21	30	60	90
4,5 – 8,0	F1	5,08	6,01	6,77	6,82	6,81	6,82	6,80
	F2	5,35	6,25	6,86	6,87	6,85	6,83	6,84
	F3	6,21	7,24	6,74	6,81	6,81	6,81	6,80

The pH test results showed that all formulas (F1, F2, and F3) had pH within the standard range of topical preparations (4.5–8.0) (Sterbova et al., 2016). F1 experienced an increase in pH from 5.08 (day 0) to 6.82 (day 21), then stabilized until day 90. F2 increased from 5.35 to 6.87 (day 21), and stabilized in the range of 6.83–6.84. F3 had the highest initial pH (6.21), increased to 7.24 (day 7), then decreased and stabilized at 6.80 since day 21.

Table 4. Viscosity Test Results

Viscosity Test Standards	F	Testing to day						
		0	7	15	21	30	60	90
2000 – 50000 cPs	F1	22890	19747	18165	19392	21127	22572	22610
	F2	19722	16813	15568	15396	15634	15430	15480
	F3	18052	14702	14325	10080	11198	13664	14050

Viscosity test results showed that Formula F1 had the best stability, with a value that had decreased from 22,890 cPs (day 0) to 18,165 cPs (day 15), then increased and stabilized in the range of 22,572–22,610 cPs until day 90. F2 experienced a gradual decrease from 19,722 cPs to 15,480 cPs. F3 showed the most significant decrease, from 18,052 cPs to 10,080 cPs, and only slightly increased to 14,050 cPs at the end of storage.

Table 5. Spreadability Test Results

Dispersion Test Standards	F	Testing to day						
		0	7	15	21	30	60	90
5 – 7 cm	F1	5,3	5	5,2	5	5,1	5,1	5,3
	F2	5,4	5,4	5	5	5,2	5,1	5,4

Dispersion Test Standards	F	Testing to day						
		0	7	15	21	30	60	90
	F3	5,6	5,7	5,5	5,1	5,4	6	5,6

The results of the spreadability test showed that Formula F1 had the best stability with a range of 5–5.3 cm for 90 days. F2 experienced mild fluctuations, from 5.4 cm to 5.2 cm. F3 showed the highest spreadability of up to 5.9 cm.

Table 6. Moisture Test Results

Panelists	Before (F1)	After (F1)	Δ (%)	Before (F2)	After (F2)	Δ (%)	Before (F3)	After(F3)	Δ (%)
1	35%	45%	10%	41%	60%	19%	39%	59%	20%
2	32%	42%	4%	32%	45%	13%	32%	45%	13%
3	32%	36%	23%	32%	41%	9%	35%	45%	10%
4	36%	59%	12%	32%	48%	16%	36%	60%	24%
5	48%	60%	24%	45%	60%	15%	44%	60%	16%
6	36%	60%	30%	41%	59%	18%	41%	49%	8%
7	10%	40%	25%	16%	60%	44%	10%	60%	50%
8	35%	60%	24%	32%	59%	27%	19%	60%	41%
9	36%	60%	13%	35%	59%	24%	40%	60%	20%
10	36%	49%	9%	35%	50%	15%	44%	52%	8%
11	35%	44%	19%	36%	60%	24%	32%	60%	28%
12	41%	60%	19%	41%	60%	19%	41%	60%	19%
13	32%	35%	3%	32%	44%	12%	33%	41%	8%
14	32%	59%	27%	33%	60%	27%	34%	60%	26%
15	34%	49%	15%	33%	50%	17%	35%	52%	17%
16	32%	50%	18%	36%	54%	18%	34%	53%	19%
17	30%	46%	16%	30%	47%	17%	31%	48%	17%
18	31%	46%	15%	28%	45%	17%	29%	44%	15%
19	33%	52%	19%	32%	51%	19%	30%	50%	33%
20	35%	58%	23%	34%	56%	22%	35%	58%	23%
Average			**17%**			**20%**			**21%**

The moisture test showed that all formulas (F1, F2, F3) were able to increase the moisture content of the panellists' skin. Formula F3 showed the highest increase in moisture, averaging 21% (range 8–50%), followed by F2 with 20% (8–44%), and F1 at 17% (3–30%). The highest effectiveness in F3 was shown by panellist number 7 with an increase of 50%.

3.2 Discussion

The pH changes in all formulas are thought to be due to adjustments to the emulsion system and interactions between ingredients, including sacha inchi oil, which is rich in unsaturated fatty acids (Kampa et al., 2022) (Anwar et al., 2020; Wang et al., 2018). A stable pH within the physiological range of the skin (4.5–6.5) supports the comfort and safety of the preparation during 90 days of storage (Marieb & Hoehn, 2018).

Viscosity plays a crucial role in the lotion's performance. The viscosity stability of F1 indicates good emulsion consistency (Pradipta, 2025), while the significant decrease in F2 and F3 may be attributed to oxidation of the unsaturated fatty acids in sacha inchi oil. Lower viscosity in F3 results in a watery texture, which might affect consumer perception and application comfort. However, moderate viscosity values are considered ideal for effective active ingredient delivery and better absorption (Denei & Reddy, 2022; Sayuti, 2015).

Spreadability is directly influenced by viscosity. Although F3 had the highest spreadability due to its lower viscosity, it risks making the lotion feel less pleasant and too runny (Walendziak, 2025). F1's stable spreadability within the ideal range indicates a balanced emulsion system that ensures good application properties (Ramos-Escudero et al., 2019).

In terms of moisturizing effect, F3 demonstrated the most significant improvement in skin hydration, supporting the hypothesis that higher concentrations of sacha inchi oil enhance the moisturizing effect (Ponphaiboon, 2024). The effectiveness of the formulation as a skin moisturizer is closely related to the presence of essential fatty acids such as linoleic acid and alpha-linolenic acid, which are abundant in sacha inchi oil and help restore skin barrier function and water retention (Wang et al., 2018). Thus, despite its lower viscosity, F3 may be considered optimal for hydration efficacy.

Overall, formulas F1, F2, and F3 meet the physical and functional criteria of a topical moisturizer, with F3 having the most promising moisturizing effect.

However, attention must be paid to optimizing viscosity for better user acceptance.

3.2.1 Implications

This study demonstrates that increasing the concentration of sacha inchi oil improves moisturizing efficacy but may adversely affect physical stability. Therefore, formulation development should carefully balance active ingredient concentration and physical robustness to achieve both clinical effectiveness and desirable sensory properties.

3.2.2 Research contribution

This research contributes to the development of evidence-based natural cosmetic products by providing scientific data on the formulation, stability, and moisturizing efficacy of Sacha Inchi oil body lotion. It supports the integration of indigenous botanical ingredients into standardized cosmetic formulations.

3.2.3. Limitations

This study focused on short-term physical stability and hydration efficacy using a skin analyzer over a 90-day storage period. It did not include microbiological stability, chemical degradation of active ingredients, or long-term dermatological safety evaluations.

3.2.4 Suggestions

Future studies should extend the stability testing to 6 months or longer and include microbiological assessments and trans-epidermal water loss (TEWL) analysis. Sensory evaluations involving a broader panel of participants with diverse skin types are also recommended to validate user acceptability.

4. CONCLUSION

Based on the results of the study, it can be concluded that variations in sacha inchi oil concentration have an effect on the physical stability of body lotion. Formulations with a concentration of 6% (Formulation 2) show the best physical stability, judging from the pH parameters, viscosity, dispersibility, and absence of phase separation during storage. Sacha inchi oil-based body lotion has also been shown to be effective in increasing skin moisture, with Formulation 3 providing the highest and most consistent increase in moisture levels compared to other formulations.

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AUTHOR CONTRIBUTION STATEMENT

NS: Supervision, Methodology Review, Writing – Review & Editing.
RP: Conceptualization, Formulation Design, Laboratory Testing, Data Analysis, Writing – Original Draft, Writing – Final Review.
FH: Instrument Operation (Skin Analyzer, Viscosity Measurement), Data Collection, Visualization.
ES: Project Administration, Resources Management, Supervision.

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REFFERENCE

Alves, A., Sousa, E., Kijjoa, A., & Pinto, M. (2020). Marine derived compounds with potential uses as cosmeceutical and nutricosmetics. *Molecules*, 25(11), 2536. https://doi.org/10.3390/molecules25112536

Badruddoza, A. Z. (2023). Assessing and Predicting Physical Stability of Emulsion-Based Topical Semisolid Products. *Journal of pharmaceutical sciences, 112(7)*, 1772–1793. https://doi.org/10.1016/j.xphs.2023.03.014

Chandrasekaran, U., & Liu, A. (2015). Stage-specific metabolization of triacylglycerols during seed germination of Sacha inchi (Plukenetia volubilis L.). *Journal of the Science of Food and Agriculture*, 95(8), 1764–1766. https://doi.org/10.1002/jsfa.6855

Denei, A. A. S., & Reddy, S. M. (2022). A Review on Formulation and Evaluation of Emulgel. *International Journal of All Research Education and Scientific Methods (IJARESM)*, *10*(2), 1378–1386. IJARESM

Densi, S. S., & Mila, A. (2019). Peel Off Mask From Carrot Ekstrak (Daucus carota L). *Borneo Journal of Pharmascientech*, *3*(2), 110-118. https://doi.org/10.51817/bjp.v3i2.245

Directorate of Standardization of Traditional Medicines, Cosmetics, and Complementary

Products, National Agency of Drug and Food Control of the Republic of Indonesia. (2020). Operational guidelines for good cosmetic manufacturing practices [Petunjuk operasional pedoman cara pembuatan kosmetik yang baik]. *Jakarta, Indonesia.*

Gonzalez-Aspajo, G., Belkhelfa, H., Haddioui-Hbabi, L., Bourdy, G., & Deharo, E. (2015). Sacha Inchi Oil (Plukenetia volubilis L.), effect on adherence of Staphylococus aureus to human skin explant and keratinocytes in vitro. *Journal of ethnopharmacology*, *171*, 330-334. https://doi.org/10.1016/j.jep.2015.06.009

Iskandar, B., Santa Eni, B. R., & Leny, L. (2021). Formulasi dan evaluasi lotion ekstrak alpukat (Persea americana) sebagai pelembab kulit. *Journal of Islamic Pharmacy*, 6(1), 14–21. https://doi.org/10.18860/jip.v6i1.11822

Juvita Herdianty, A. W. (2023). Formulation and Stability Test of Herbal Cosmetic Preparations. *Health Scientific Journal 4(2)*, 59-63. https://doi.org/10.55700/oahsj.v4i2.45

Kampa, J., Frazier, R., & Rodriguez-Garcia, J. (2022). Physical and Chemical Characterisation of Conventional and Nano/Emulsions: Influence of Vegetable Oils from Different Origins. *Foods (Basel, Switzerland)*, *11*(5), 681. https://doi.org/10.3390/foods11050681

Maya, I. S. (2024). Formulation and Evaluation of Facial Serum Containing Sacha Inchi Oil (Plukenetia volubilis L.) from Indonesia as an Anti-Aging: Stability, In Vitro, and Skin Irritation Assessments. *Cosmetics, 11(6)*, 226. https://doi.org/10.3390/cosmetics11060226

Marieb, E. N., & Hoehn, K. (2018). Human Anatomy & Physiology (11th ed.). Pearson Education.

Megantara, I. N. A. P., et al. "Formulasi Lotion Ekstrak Buah Raspberry(rubus Rosifolius) Dengan Variasi Konsentrasi Trietanolamin Sebagai Emulgator Serta Uji Hedonik Terhadap Lotion." *Jurnal Farmasi Udayana*, vol. 6, no. 1, 2017, pp. 1-5. https://doi.org/10.24843/JFU.2017.v06.i01.p01

Ningsih, A. W., Klau, I. C. S., & Wardani, E. P. (2021). Studi formulasi hand body lotion ekstrak etanol kunyit (*Curcuma domestica* Val.). *FARMASIS: Jurnal Sains Farmasi*, 2(1), 32–37. https://doi.org/10.36456/farmasis.v2i1.3621

Pradipta, S. A., Ariani, L. W., & Sari, W. K. (2025). Optimization of Liquid Paraffin as an Emollient and Propylene Glycol as a Humectant in the Formulation of Body Lotion containing Alpha-Arbutin. *Journal of Food and Pharmaceutical Sciences*, *13*(1), 45-53. https://doi.org/10.22146/jfps.17766

Ponphaiboon, J. L. (2024). Development and Evaluation of a Stable Oil-in-Water Emulsion with High Ostrich Oil Concentration for Skincare Applications. *Molecules, 29(5)*, 982. https://doi.org/10.3390/molecules29050982

Rahayu, S. (2016). *The effect of different concentrations of white turmeric extract (Curcuma manga Val.) on the physical properties of lotion* [Hubungan perbedaan konsentrasi ekstrak kunyit putih (Curcuma manga Val) terhadap sifat fisik lotion]. *Proceedings of the National Working Meeting and Annual Scientific Meeting of the Indonesian Pharmacists Association*, 2541–0474.

Ramos-Escudero, F., Munoz, A. M., & Ramos Escudero, M. (2019). Characterization of commercial Sacha inchi oil according to its composition: tocopherols, fatty acids, sterols, triterpene and aliphatic alcohols. *J Food Sci Technol*, *56*, 4503–4515. https://doi.org/10.1007/s13197-019-03938-9

Ravera, F., Dziza, K., Santini, E., Cristofolini, L., & Liggieri, L. (2021). Emulsification and emulsion stability: The role of the interfacial properties. *Advances in Colloid and Interface Science*, *288*, 102–344. https://doi.org/10.1016/j.cis.2020.102344

Sayuti, N. A. (2015). Formulasi dan Uji Stabilitas Fisik Sediaan Gel Ekstrak Daun Ketepeng Cina (Cassia alata L.). *Indonesian Pharmaceutical Journal*, *5*(2), 74–82. https://doi.org/10.22435/jki.v5i2.3500

Sterbova, L., Hiasna, P., Viehmannova, I., & Huansi, D. C. (2016). Effect of Thermal Processing on Phenolic Content, Tocopherols and Antioxidant Activity of Sacha Inchi Kernels. *Journal of Food and Preservation*, *41*(2). https://doi.org/10.1111/jfpp.12848

Trindade, G. A. (2024). Polysaccharide-Stabilized Semisolid Emulsion with Vegetable Oils for Skin Wound Healing: Impact of Composition on Physicochemical and Biological Properties. *Pharmaceutics, 16(11)*, 1426. https://doi.org/10.3390/pharmaceutics16111426

Walendziak, W., Douglas, T. E. L., & Kozlowska, J. (2025). Design, Optimization, and Characterization of Freeze-Dried Emulsions Based on Sodium Alginate and Whey Protein Isolate Intended for Cosmetic and Dermatological Applications. *ACS omega*, *10*(23), 24932–24949. https://doi.org/10.1021/acsomega.5c02358

Wang, S., Zhu, F., & Kakuda, Y. (2018). Sacha inchi (Plukenetia volubilis L.): Nutritional composition, biological activity, and uses. *Food Chemistry*, *265*, 316–328. https://doi.org/10.1016/j.foodchem.2018.05.055

Wikantyasning, E. R., & Wahyuni, T. T. (2024). Optimization and formulation of skin lotion containing Butterfly pea (Clitoria ternatea)

flower extract and study on its antioxidant activity. BIO Web of Conferences, 135, 03001. https://doi.org/10.1051/bioconf/202413503001

Wuttisin, N. (2017). Fatty acid composition of Sacha inchi (Plukenetia volubilis L.) oil and efficacy of Sacha inchi lotion. *Journal of Science and Technology Ubon Ratchathani University, Special Issue September*, 120–127. thaiscience.info