Optimization of a Niacinamide Moisturizing Cream Formula Using a Combination of Virgin Coconut Oil and Tea Tree Oil as the Oil Phase

Rahmat Muliadi[1*], Vica Aspadiah[1], Suryani[1], Wa Ode Sitti Zubaydah[1], Fery Indradewi Armadany[1], Purnama Alia Rizki[1]
[1]Department of Pharmacy, Faculty of Pharmacy, Universitas Halu Oleo, Southeast Sulawesi, Indonesia

*Corresponding Author: rahmatmuliadi@uho.ac.id

ABSTRACT

Skin acts as a critical barrier against water and electrolyte loss, and its compromise leads to dry, dull, scaly, and unevenly white areas. To restore hydration, topical moisturizers particularly creams employing occlusive, humectant, and emollient mechanisms are essential. Virgin coconut oil (VCO) and Tea Tree Oil (TTO) are widely recognized for their safety and complementary moisturizing properties, and their incorporation alongside niacinamide may yield a synergistic effect. This study aimed to optimize a niacinamide-containing moisturizing cream by varying the oil phase composition (VCO and tea tree oil) using a 2^2 factorial design in Design-Expert® software, and to evaluate key physical characteristics and stability. Two factors (VCO and TTO concentrations) were assessed for their influence on viscosity, dispersion, and adhesion. Stability was monitored via organoleptic evaluation, pH measurement, dispersion area, adhesion time, and homogeneity before and after accelerated cycling tests and phase-separation assessments. The optimized formulation demonstrated robust dosage characteristics: viscosity values of 12,328.735 cP (pre-cycling) and 12,328.731 cP (post-cycling); pH levels of 6.1 and 6.5, respectively; a dispersion area of 6.6 cm both before and after cycling; adhesion times of 86.33 s and 85.67 s; and consistently homogeneous appearance. All parameters remained within established stability criteria, confirming that the VCO–TTO combination enhances the physical stability and quality of a niacinamide moisturizing cream. This optimized formulation shows promise for effective management of dry skin.

Keywords: Moisturizing cream, TTO, VCO.

INTRODUCTION

Skin, as the body's outermost organ, acts as the principal barrier against fluid loss and environmental aggressors. Its barrier function tightly controls transepidermal water loss and blocks harmful substances; when this function falters, dry skin (xerosis) develops manifesting as flakiness, rough texture, tension, and a proneness to irritation at any age. Key drivers of barrier impairment include low humidity, intrinsic aging, and the repeated use of harsh cleansers or irritants that strip away the skin's natural moisture (Butarbutar & Chaerunisaa, 2020; Wijayadi & Wardoyo, 2022).Maintaining optimal hydration is essential to prevent conditions such as atopic eczema and dermatitis.

To address these skin concerns, moisturizers can be an effective solution. Their mechanisms of action are categorised into three groups: occlusives, humectants and emollients. Occlusives (such as petrolatum) form a protective layer on the skin's surface, thereby reducing transepidermal water loss. Humectants (such as glycerin, sorbitol and propylene glycol) attract and bind water from the environment or from the dermis into the stratum corneum. Emollients (lipids such as linoleic acid, stearate, palmitate, cholesterol and ceramides) fill the gaps between corneocytes, smoothing the skin's surface. These three mechanisms work synergistically to enhance hydration of the corneum and restore a damaged skin barrier. An optimal moisturizer formulation typically combines all three mechanisms to achieve superior hydration (Butarbutar & Chaerunisaa, 2020; Rakhma et al., 2021). One of the most commonly used dosage forms for moisturizers is cream.

In cosmetics and dermatological products, a cream is a semi-solid topical preparation in which one or more active ingredients are dissolved or dispersed in a suitable base. Creams can impart a glossy, oily, and moisturizing effect and are prized for their ease of even application. Their advantages include user comfort, good absorption, non-greasiness and easy removal with water (Elmitra, 2019; Tari et al., 2023). A moisturizing cream may be fortified with actives that function as brightening agents, one of which is niacinamide. Niacinamide (nicotinamide), the amide form of vitamin B_3, is widely used in skincare as a depigmenting agent. It inhibits melanosome transfer from melanocytes to keratinocytes, thereby preventing melanin accumulation in the epidermis and brightening the complexion. Additionally, niacinamide strengthens the skin barrier and exhibits anti-inflammatory effects (Rollando, 2023).

In the oil phase, this cream formulation utilises Virgin Coconut Oil (VCO) and Tea Tree Oil (TTO). VCO, which is rich in lauric acid and antioxidants, exerts anti-inflammatory and antioxidant effects on the skin. Recent studies have shown that VCO downregulates inflammatory mediators (TNF-α, IL-6) and enhances antioxidant enzyme activity (SOD, GSH), thereby restoring skin barrier function and alleviating irritation (Logamorthy & Karthikeyan, 2025). TTO (*Melaleuca alternifolia*) contains terpinen-4-ol as its principal component, conferring broad-spectrum antimicrobial activity and potent anti-inflammatory properties. It has been demonstrated to be effective against bacteria, fungi and viruses responsible for skin infections, as well as to accelerate wound healing and reduce inflammation (Pazyar et al., 2013). The combination of VCO and TTO in

this moisturizing cream is expected to act synergistically, enhancing hydration and providing additional protection against dry skin. Both VCO and TTO are considered safe for inclusion in topical moisturizer formulations (Damhas & Widayanti, 2015).

To develop the optimal cream formulation, a Design of Experiments (DoE) approach using a factorial design was employed. This method systematically varies the levels of excipients in each trial and then evaluates the physical responses (pH, viscosity, spreadability and stability) through analysis of variance. Consequently, this approach yields the niacinamide-enriched moisturizer formula combined with VCO and tea tree oil that demonstrates the most favourable physical characteristics (pH, viscosity, spreadability and stability) (Alta et al., 2021; Puspitasary et al., 2020; Saryanti et al., 2019).

METHODS

Materials

The equipment used in the formulation includes a 250 mL beaker (Iwaki®), 50 mL beaker (Pyrex®), 500 mL beaker (Pyrex®), stirring rod (Pyrex®), spatula (Pyrex®), analytical balance (Fujitsu FS-AR®), 100 mL graduated cylinder (Pyrex®), dropping pipettes, volumetric pipette (Pyrex®), oven (Stuart®), refrigerator, mortar and pestle, weights, porcelain crucibles (Haldenwanger®), petri dishes (Pyrex®), pH meter (Jenway®), magnetic stirrer (Stuart®), centrifuge (Stuart®), Brookfield viscometer, microtubes (LPI), water bath (Stuart®), stopwatch, and cream containers. The materials used in this research are Niacinamide (Quadrant®), VCO (Virgin Coconut Oil) (Quadrant®), Tea Tree (Quadrant®), Glycerin (Quadrant®), DMDM hydantoin (Quadrant®), Phenoxyethanol (Quadrant®), Tween 80 (Quadrant®), Span 80 (Quadrant®), Vitamin E (Quadrant®), Xanthan Gum (Quadrant®), Rose Oil (Oleum Rosae) (Quadrant®), and distilled water (aquadest).

Methods

Determination of the Optimum Moisturizer Cream Formulation

A 100 g moisturizer cream formulation containing niacinamide in combination with Virgin Coconut Oil (VCO) and tea tree oil was developed. In this formulation, the two excipient factors optimised as the oil phase were VCO (5 %–7 % w/w) and tea tree oil (0.5 %–1 % w/w) (Widyastuti & Saryanti, 2023) These percentage ranges served as the design constraints in Design Expert version 13. The experimental design generated 12 distinct formulations, each evaluated for three responses: viscosity, spreadability and adhesiveness. The independent and dependent variables used to determine the optimum cream formulation are detailed in Table 1.

Table 1. Independent and Dependent Variables in the2^2 Factorial Design for Determining the Optimum Formulation

Experimental Variable	Limitations		
Independent	**Lower Limit**	**Upper Limit**	**Targets**
VCO	5%	7%	In range
Tea tree oil	0.5%	1%	In range
Dependent			
Viscosity	2000 cps	50000 cps	Minimize
Spreadability	5 cm	7 cm	Maximize
Adhesiveness	2 s	200 s	Maximize

The composition of the optimal moisturizer cream formulation is presented in Table 2.

Table 2. Moisturizer Cream Formulation Design

Ingredients	Function	Concentrations (%)			
		1	2	3	4
Niacinamide	Active ingredients	5	5	5	5
VCO	Oil Phase	5	7	5	7
Tea tree oil	Oil Phase	1	1	0.5	0.5
Glycerine	Humectant	5	5	5	5
Tween 80	Emulsifier	3	3	3	3
Span 80	Emulsifier	3	3	3	3
Oleum Rosae	Fragrance	0.05	0.05	0.05	0.05
Phenoxy ethanol	Preservative	0.5	0.5	0.5	0.5
DMDM hydantoine	Preservative	0.2	0.2	0.2	0.2
Vitamin E	Antioxidant	0.05	0.05	0.05	0.05
Xanthan Gum	Thickener	0.3	0.3	0.3	0.3
Distilled Water	Solvent	Ad 100	Ad 100	Ad 100	Ad 100

*Each formulation was replicated 3 times.

The weighed ingredients for each formulation were prepared as follows: the oil-phase components were heated in a water bath at 60–70 °C. The aqueous-phase ingredients were dissolved in 5 mL of distilled water pre-heated to 70 °C, with constant stirring in a water bath maintained at 70 °C. The heated oil phase was then added to the aqueous phase and stirred for 5 minutes. After removal from the water bath, glycerin was incorporated, followed by the addition of xanthan gum and the remaining distilled water, with mixing continued at constant speed. Finally, rose oil (oleum rosae) was added and stirred until the mixture was homogeneous, after which the cream was ready to be packaged (Datu et al., 2019).

RESULTS AND DISCUSSION

Optimisation of the Moisturizer Cream Formulation

The optimisation method employed in this study was a 2^2 factorial design, which enables the simultaneous determination of the dominant effects and interactions

between two factors Virgin Coconut Oil (VCO) (5–7 %) and Tea Tree Oil (TTO) (0.5–1 %) on the physical properties of the moisturizer cream. Each factor has two levels (low and high), and their effects were measured via three responses: viscosity (2,000–50,000 cps), spreadability (5–7 cm) and adhesiveness (2–200 seconds). Optimisation was carried out by setting target ranges (goals) for each response and performing 2^n trials (n = 2), yielding four formulations with three replications each (12 runs). The measured viscosity, spreadability and adhesiveness for each formulation were then analysed to determine the VCO–TTO composition ranges that meet the optimal criteria **(**Table 3**)**.

Table 3. Response Results for Viscosity, Spreadability and Adhesiveness

Run	Factors		Responses		
	VCO (%)	Tea Tree Oil (%)	Viscosity (cps)	Spread ability (cm)	Adhesive ness (s)
1	7	0.5	26210.8	5.5	124
2	5	0.5	27042.2	6	128
3	7	1	5174.27	7	60
4	7	0.5	26441.7	5.5	122
5	5	0.5	35427.9	5	132
6	5	1	25231.2	5.5	120
7	7	1	5227.81	7	66
8	5	1	34274.3	5	129
9	5	1	26542.2	6	125
10	5	0.5	33549.3	5	126
11	7	0.5	5286.81	7	64
12	7	1	26586.2	6	127

The optimum formulation is determined by the desirability value, an optimisation function reflecting how well the programme meets the final product criteria the closer to 1.0, the more optimal (Ramadhani et al., 2017). Of the five candidates, the first formulation, with the highest desirability of 0.648 **(**Table 4**)**, proved optimal at 7 % VCO and 1 % TTO. The predicted physical properties under these conditions are a viscosity of 12,329 cps, spreadability of 6.667 cm and adhesiveness of 84.333 seconds. Contour plot analysis shows that the region defined by this VCO–TTO combination falls within the desired ranges for viscosity, spreadability and adhesiveness, whilst also revealing the interaction between the two ingredients in influencing the moisturizer cream's characteristics.

Table 4. Formulation Solutions Based on Desirability Values

VCO (%)	Tea Tree Oil (%)	Viscosity (cps)	Spread ability (cm)	Adhesi veness (s)	Desir abilit y
7.000	1.000	12329.427	84.333	6.667	0.648
7.000	0.997	12368.738	84.440	6.663	0.647
6.980	1.000	12490.992	84.732	6.655	0.647
6.946	1.000	12772.615	85.426	6.635	0.644
6.848	1.000	13575.999	87.408	6.578	0.637

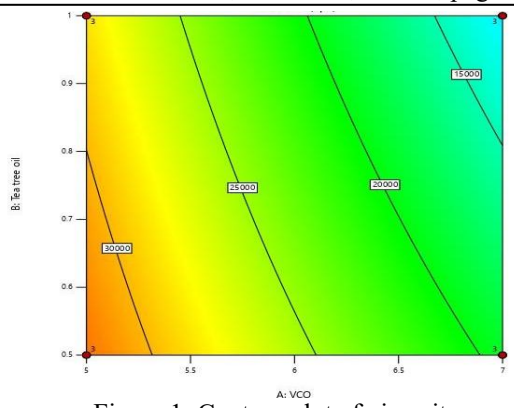

Figure 1. Contour plot of viscosity

Viscosity Response

Based on the contour plot at Figure 1, the viscosity of the moisturizing cream increases when the concentrations of VCO and TTO are low, and conversely, the viscosity decreases as the VCO and TTO content increases. This is due to the higher oil phase slowing down homogenization by the emulsifier, resulting in a thinner product.

The blue zones in the plot represent areas of low viscosity, whereas the red zones indicate areas of high viscosity. This phenomenon aligns with emulsion principles, which state that an increased oil phase tends to reduce interfacial tension and form a looser gel structure, thereby decreasing viscosity (Montgomery, 2017), it is also consistent with findings showing that the addition of natural oils can reduce cream viscosity while maintaining physical stability (Wardoyo et al., 2022).

Spreadability Response

Based on the contour plot at Figure 2, increasing the concentrations of VCO from 5 % to 7 % and TTO from 0.5 % to 1 % synergistically enhances the spreadability of the moisturizer cream: the blue zone (~5.4 cm) shifts towards yellow-red (~6.6 cm).

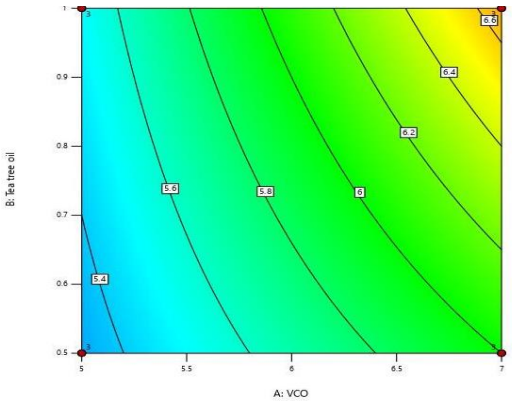

Figure 2. Contour plot of spreadability

This is attributed to the higher oil phase reducing interfacial tension and improving lubrication between emulsion droplets, thereby facilitating easier spreading (Montgomery, 2017). These findings are consistent with (Wardoyo et al., 2022) who reported that formulations with a greater oil-phase content exhibit higher spreadability

without compromising physical stability, and with Wulansari et al., (2017) who observed increased spreadability in tea tree oil nanoemulsions as surfactant and oil-phase concentrations.

Adhesiveness Response

According to the contour plot at Figure 3, simultaneously decreasing the concentrations of VCO and TTO enhances the cream's adhesiveness: the green zone (~90 seconds) shifts to red (~120 seconds).

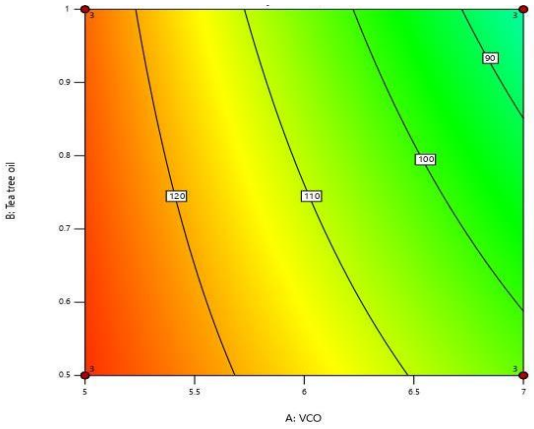

Figure 3. Contour plot of adhesiveness

This is because formulations with higher viscosity take longer to flow, thereby increasing their adhesion to the skin surface. This observation aligns with emulsion theory, which posits that a greater oil phase strengthens the internal gel network and cohesion forces, causing the cream to remain "stuck" longer before moving. Other studies have similarly reported a positive correlation between higher viscosity and increased adhesiveness in natural oil-based cosmetic creams (Montgomery, 2017; Wijayadi & Wardoyo, 2022). Understanding this VCO–TTO interaction is crucial for optimising the formulation; the optimum composition determined by Design Expert is presented in Table 5.

Table 5. Optimal Moisturizer Cream Formulation Obtained via Design Expert Optimization

Ingredients	Function	Concentrations (%)
Niacinamide	Active ingredients	5
VCO	Oil Phase	5
Tea tree oil	Oil Phase	0.5
Glycerine	Humectant	5
Tween 80	Emulsifier	3
Span 80	Emulsifier	3
Oleum Rosae	Fragrance	0.05
Phenoxy ethanol	Preservative	0.5
DMDM hydantoine	Preservative	0,2
Vitamin E	Antioxidant	0.05
Xanthan Gum	Thickener	0.3
Distilled Water	Solvent	Ad100

The confirmation process using the optimum formulation showed in Table 6.

Table 5. Confirmation of Experimental Design Results

Analysis	Predicted mean value	Experimental mean Value	95% Prediction Index	
			Low	High
Viscosity	12329.4	12397.3	5112.41	29771,3
Spreadability	84.3333	83.6667	36.6511	132.016
Adhesion	6.66667	6.7	5.4513	7.88240

Two-sided Confidence = 95%

The results showed that the experimental values for viscosity (12,397.3 cps), spreadability (6.7 cm) and adhesiveness (83.67 seconds) aligned with the Design Expert® predictions (12,329.4 cps; 6.6667 cm; 84.3333 seconds) and remained within the 95 % prediction intervals (viscosity 5,112–29,771 cps; spreadability 5.45–7.88 cm; adhesiveness 36.65–132.02 seconds), thereby confirming the validity of the optimisation model. This is consistent with the factorial model validation principle that confirmation data must lie within the prediction intervals to ensure the reliability of the desirability function and experimental design (Montgomery, 2017; Ramadhani et al., 2017).

Stability Tests of the Optimal Moisturizer Cream Formulation

The physical stability test of the optimum body lotion formulation was conducted using the cycling test method over six cycles. The evaluation parameters included organoleptic properties, pH, viscosity, spreadability, adhesiveness, and homogeneity. The results of the stability test are presented in Table 7.

Table 7. Stability Test Results of the Optimum Body Lotion Formula

No	Tests	Stability Tests	
		Pre-Cycling	Post-Cycling
1	Organoleptic	White, characteristic odor oleum rosae, thick	White, characteristic odor oleum rosae, thick
2	pH	6,1	6,5
3	Viscosity	12328.735	12328.731
4	Spreadability	6.6 cm	6.6 cm
5	Adhesion	86.33	85.67
6	Homogeneity	Homogen	Homogen

The organoleptic assessment of three replicates of the optimum formulation demonstrated consistent characteristics before and after storage: a white colour, a thick texture, a distinctive rose oil aroma, and no phase separation, indicating good emulsion homogeneity and stability. This aligns with established cosmetic stability theory, which recognises the retention of organoleptic properties, colour, odour, and texture as key indicators of a cream's long-term quality, and supports the principle that a stable emulsion will maintain its physical characteristics throughout temperature and time-dependent storage cycles (Thomas et al., 2024).

The pH evaluation of the moisturizer cream revealed an average increase from 6.1 to 6.5 following the thermal cycling test; nevertheless, this value remains within the skin's normal pH range (4.5–6.5), ensuring safety and non-irritancy (Unique, 2018). Such pH fluctuations are consistent with the theory that changes in acidity can arise from chemical reactions of active ingredients or excipients, interactions with the container, and environmental storage conditions (Thomas et al., 2024). With the final pH maintained at 6.5 across all three replicates, the formulation demonstrates its ability to preserve the skin's ideal pH throughout the physical stability process.

Viscosity reflects the flow resistance of the moisturizer cream and serves as a key parameter for cream stability the higher the viscosity, the slower the movement of cream particles, thereby enhancing stability and increasing adhesion to the skin, although spreadability may be reduced. Viscosity testing across three replicates showed an average value of 12,328.7 cps both before and after the stability evaluation (Cycling Test), which falls within the ideal range defined by SNI 16 4399 1996 (2,000–50,000 cps) and current literature (Thomas et al., 2024). The positive correlation between viscosity and adhesiveness, and its inverse relationship with spreadability, aligns with the theory proposed by Saputri & Rahma (2021), in which an increased oil phase leads to a more rigid internal network and enhances the cream's internal cohesive strength**.**

Spreadability testing showed an average value of 6.6 cm both before and after the stability cycle, which lies within the ideal range of 5–7 cm as defined by Kumalasari et al., (2020), This indicates that the moisturizer cream exhibits effective and stable spreadability upon application. This finding is consistent with the theory that a wider spread area reflects more efficient distribution of active ingredients on the skin, ensuring uniform absorption and action (Thomas et al., 2024). The sustained spreadability following the cycling test also demonstrates physical stability against temperature fluctuations and storage conditions.

The adhesiveness of a moisturizer cream i.e. the duration it remains adhered to the skin correlates with its viscosity and influences the effective delivery of active ingredients (Thomas et al., 2024). The test results showed an average adhesiveness of 86.33 seconds before and 85.67 seconds after the cycling test, meeting the minimum adhesion standard of 4 seconds (SNI 16 4399 1996). This consistency indicates formulation stability and optimal skin contact time for active ingredient penetration, in line with the theory that increased viscosity prolongs contact duration and adhesion (Patel & Santra, 2020).

Homogeneity in a moisturizer cream is achieved when all components are thoroughly mixed, indicated by consistent colour and texture without clumps, both before and after testing. According to Wardani et al. (2021), homogeneity testing is conducted by spreading a thin layer of cream between two glass slides to confirm the absence of coarse particles or phase separation both markers of long-term product stability. The consistent homogeneity across all three replicates before and after the stability cycle reflects even distribution of active ingredients, supporting efficacy and optimal absorption. Oil-in-water emulsion theory affirms that homogeneity is essential for maintaining physical characteristics throughout storage (Pratiwi & Hidayat, 2023).

Cream Type

Emulsion type testing using the dilution method (Spasic, 2018) showed that when the cream was mixed with water and stirred, the emulsion remained stable and homogeneous, and similarly remained stable when mixed with oil. Thus, the cream is classified as an oil-in-water (O/W) emulsion. This aligns with the theory that O/W emulsions contain oil droplets dispersed in a water phase, offering a light texture that is easy to rinse off and suitable for moisturizer formulations due to improved release of active ingredients to the skin (Sousa et al., 2022).

Phase Separation Test

The phase separation test using centrifugation aims to assess the emulsion's stability against gravitational forces. The absence of phase separation, indicated by the lack of a liquid layer above or below the formulation, reflects the moisturizer cream's resistance to centrifugal stress (Saryanti et al., 2019). This aligns with the oil-in-water emulsion stability theory, which states that a stable emulsion maintains the distribution of both continuous and dispersed phases under mechanical stress due to low interfacial tension and homogeneous particle size (Widyastuti & Saryanti, 2023).

CONCLUSION

The conclusion drawn from this study is that the optimum formula for the moisturizing cream was obtained with a combination of 7% Virgin Coconut Oil (VCO) and 1% tea tree oil, as determined using the Design Expert® software. The optimized formula exhibited physical characteristics that met the required standards, as evidenced by evaluations of organoleptic properties, viscosity, pH, spreadability, and adhesiveness. Furthermore, the stability of the optimized formula was confirmed through phase separation testing and a 12-cycle cycling test, demonstrating that the formulation remained stable in terms of organoleptic properties, viscosity, pH, spreadability, and adhesiveness.

ACKNOWLEDGEMENTS

The authors express their deepest gratitude to the Faculty of Pharmacy, Halu Oleo University for providing the necessary facilities, equipment, and infrastructure throughout the research process. The authors also appreciate the entire laboratory staff of the Faculty of Pharmacy at Halu Oleo University for their technical assistance in conducting the physical evaluation and stability testing of the formulation. This research would not have been successfully completed without the contributions of the various parties who supported it, both directly and indirectly.

REFERENCES

Alta, U., Pratiwi, G., & Arina, Y. (2021). Optimasi Formula Blush On Cream Menggunakan Pewarna Alami

Ekstrak Wortel (Daucus Carota L) dengan Metode Factorial Design. Jurnal Ilmiah Bakti Farmasi, 6(2).

Butarbutar, M. E. T., & Chaerunisaa, A. Y. (2021). Peran Pelembab dalam Mengatasi Kondisi Kulit Kering. Majalah Farmasetika, 6(1), 56-69.

Damhas, U. K., & Widayanti, R. I. (2015). Efektivitas Campuran Ekstrak Aloe Vera Dan Tea Tree Oil Dalam Formulasi Pelembab dalam Formulasi Pada Kekeringan Kulit. Jurnal Kedokteran Diponegoro, 4(4), 1552-1560.

Datu, K. A. T., Fitriani, N., & Ahmad, I. (2019, October). Pengaruh Penggunaan Metode Lactic Acid-Sucrose Dengan Microwave Assisted Extraction (Mae) Terhadap Polifenol Total dari Herba Suruhan (Peperomia Pellucida (L.) Kunth). In Proceeding of Mulawarman Pharmaceuticals Conferences (Vol. 10, Pp. 114-117).

Elmitra, E. (2019). Uji Sifat Fisik Formulasi Krim Tipe A/M dari Ekstrak Daun Singkong (Manihot Utilissima). Jurnal Ilmiah Pharmacy, 6(1), 149-157.

Kumalasari, E., Mardiah, A., & Sari, A. K. (2020). Formulasi Sediaan Krim Ekstrak Daun Bawang Dayak (Eleutherine Palmifolia (L) Merr) Dengan Basis Krim Tipe A/M dan Basis Krim Tipe M/A. Afamedis, 1(1), 23-33.

Logamorthy, R., & Karthikeyan, K. (2025). Coconut Oil–Nature's Own Emollient. Indian Journal Of Dermatology, Venereology And Leprology, 1-3.

Montgomery, D. C. (2017). Design And Analysis Of Experiments. John Wiley & Sons.

Patel, H. A., & Santra, A. (2020). Organically Modified Layered Magnesium Silicates to Improve Rheology of Reservoir Drilling Fluids. Scientific Reports, 10(1), 13851.

Pazyar, N., Yaghoobi, R., Bagherani, N., & Kazerouni, A. (2013). A Review of Applications of Tea Tree Oil In Dermatology. International Journal of Dermatology, 52(7), 784-790.

Puspitasary, K., Kuncahyo, I., & Rahayu, M. P. (2020). Optimasi Formula Krim Daun Jengkol (Pithecollobium Lobatum Benth) Sebagai Antibakteri Menggunakan Desain Faktorial. Avicenna: Journal of Health Research, 3(1), 105-118.

Rakhma, D. N., Nailufa, Y., Najih, Y. A., & Wahjudi, H. (2021). Optimization of Skin Moisturizer Formula Based on Fixed Oil (Vco, Olive Oil, And Jojoba Oil): Optimasi Formula Pelembab Kulit Berbasis Minyak Nabati (Vco, Minyak Zaitun dan Minyak Jojoba). Journal Pharmasci (Journal of Pharmacy And Science), 6(2), 109-114.

Ramadhani, R. A., Riyadi, D. H. S., Triwibowo, B., & Kusumaningtyas, R. D. (2017). Review Pemanfaatan Design Expert Untuk Optimasi Komposisi Campuran Minyak Nabati Sebagai Bahan Baku Sintesis Biodiesel. Jurnal Teknik Kimia dan Lingkungan, 1(1), 11-16.

Rollando, R. (2023). Pengembangan Spektrofotometer Derivatif dan Kemometrik Multivariat Pada Sediaan Kosmetik Yang Mengandung Niacinamide dan Vitamin C Pada Kosmetika Pencerah. Jurnal Wiyata: Penelitian Sains dan Kesehatan, 10(2), 120-134.

Saryanti, D., Setiawan, I., Safitri, R. A., Farmasi, D. T., D3, P., Sekolah, F., Ilmu, T., Nasional, K., & Tradisional, D. O. (2019). Optimasi Formula Sediaan Krim M/A dari Ekstrak Kulit Pisang Kepok (Musa Acuminata L.)

Saryanti, D., Setiawan, I., & Safitri, R. A. (2019). Optimasi Asam Stearat dan Tea Pada Formula Sediaan Krim Ekstrak Kulit Pisang Kepok (Musa Paradisiaca L.). Jurnal Riset Kefarmasian Indonesia, 1(3), 225-237.

Sousa, A. M., Pereira, M. J., & Matos, H. A. (2022). Oil-In-Water And Water-In-Oil Emulsions Formation and Demulsification. Journal of Petroleum Science and Engineering, 210, 110041.

Spasic, A. M. (2018). Rheology of Emulsions: Electrohydrodynamics Principles (Vol. 22). Academic Press.

Tari, M., & Indriani, O. (2023). Formulasi Dan Uji Stabilitas Fisik Sediaan Krim Ekstrak Sembung Rambat (Mikania Micrantha Kunth). Babul Ilmi Jurnal Ilmiah Multi Science Kesehatan, 15(1).

Thomas, N. A., Muâ, A., Latif, M. S., Hutuba, A. H., & Susanti, S. (2024). Formulasi dan Uji Stabilitas Fisik Krim Pelembab Ekstrak Rumput Laut (Eucheuma Cottonii). Indonesian Journal of Pharmaceutical Education, 4(1).

Unique, I. G. A. N. P. (2018). Optimasi Konsentrasi Setil Alkohol Sebagai Agen Pengental Pada Formula Krim Ekstrak Rimpang Kunyit (Curcuma Domestica). Jurnal Farmasi Udayana, 7(2), 40-44.

Wardoyo, A. H., Soerijadi, A., & Wijayadi, L. J. (2022). Peran Helichrysum Italicum Sebagai Anti Inflamasi Pada Terapi Dermatitis Atopi. Cermin Dunia Kedokteran, 49(12), 708-710.

Wardoyo, A. H., Soerijadi, A., & Wijayadi, L. J. (2022). Peran Helichrysum Italicum Sebagai Anti Inflamasi Pada Terapi Dermatitis Atopi. Cermin Dunia Kedokteran, 49(12), 708-710.

Widyastuti, A. I., & Saryanti, D. (2023). Formulasi dan Evaluasi Sediaan Nanoemulsi Ekstrak Umbi Bawang Putih (Allium Sativum L.): Formulation and Evaluation of Nanoemulsion of Garlic (Allium Sativum L.) Extract. Jurnal Sains dan Kesehatan, 5(2), 178-185.

Wijayadi, L. J., & Wardoyo, A. H. (2022). Peran Hidrasi Kulit dan Perbaikan Sawar Kulit Pada Xerosis dan Pruritus di Usia Lanjut. Jurnal Muara Medika dan Psikologi Klinis, 2(1), 73–82.

Wulansari, A., Jufri, M., & Budianti, A. N. G. K. Y. (2017). Studies on The Formulation, Physical Stability, And In Vitro Antibacterial Activity of Tea Tree Oil (Melaleuca Alternifolia) Nanoemulsion Gel. Int. J. Appl. Pharm, 9(1), 135-139.