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Formulation and Physicochemical Evaluation of Telang Flower (*Clitoria ternatea*) Extract Lotion as a Skin Moisturizer

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ABSTRACT

Dry skin is a common dermatological condition that can adversely affect both comfort and appearance. Natural moisturisers, such as butterfly pea flower (*Clitoria ternatea*), offer a safe alternative due to their flavonoid and anthocyanin content, which provide antioxidant properties and enhance skin hydration. This study aimed to formulate and evaluate hand and body lotion containing *C. ternatea* extract and to assess the effect of varying extract concentrations on its physicochemical properties and moisturising efficacy. An experimental study with a quantitative descriptive design was conducted. Three formulations containing 1%, 3%, and 5% extract were prepared using the maceration method with 96% ethanol. Physicochemical evaluations included organoleptic, homogeneity, pH, spreadability, adhesion, and skin moisture tests, with statistical analysis using one-way ANOVA. All formulations met the quality requirements for topical preparations. Significant differences ($p < 0.05$, ANOVA) were observed in pH, adhesion, and moisture, while spreadability showed no significant differences among formulations. The results demonstrate that *C. ternatea* extract can be successfully incorporated into lotion formulations with effective moisturising properties. Further research should include long-term stability testing, in vivo efficacy and safety assessments, and consumer acceptability evaluations.

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ABSTRAK

Kulit kering merupakan kondisi dermatologis yang umum terjadi dan dapat mengganggu kenyamanan serta penampilan. Pelembap berbahan alami, seperti bunga telang (*Clitoria ternatea*), merupakan alternatif yang aman karena mengandung flavonoid dan antosianin yang bersifat antioksidan dan dapat meningkatkan hidrasi kulit. Penelitian ini bertujuan memformulasikan dan mengevaluasi sediaan hand and body lotion ekstrak *C. ternatea* serta menilai pengaruh variasi konsentrasi terhadap sifat fisikokimia dan efektivitas pelembapannya. Penelitian ini menggunakan metode eksperimental dengan desain deskriptif kuantitatif. Tiga formula dengan konsentrasi ekstrak 1%, 3%, dan 5% dibuat menggunakan metode maserasi dengan etanol 96%. Evaluasi sifat fisikokimia meliputi uji organoleptis, homogenitas, pH, daya sebar, daya lekat, dan kelembapan kulit, dengan analisis statistik menggunakan uji One Way ANOVA. Seluruh formula memenuhi persyaratan mutu sediaan topikal. Hasil menunjukkan perbedaan yang signifikan ($p < 0{,}05$, ANOVA) pada uji pH, daya lekat, dan kelembapan kulit, sedangkan daya sebar tidak menunjukkan perbedaan signifikan antar formula. Hasil ini menunjukkan bahwa ekstrak *C. ternatea* dapat diformulasikan dalam lotion dengan efektivitas pelembap yang baik. Penelitian lanjutan disarankan mencakup uji stabilitas jangka panjang, uji efektivitas dan keamanan in vivo, serta uji penerimaan konsumen.

Kata Kunci: Bunga telang; *Clitoria ternatea*; Evaluasi fisikokimia; *Hand and body lotion*; Pelembap

1. Introduction

Skin serves as the body's primary protective barrier and comprises three structural layers: the epidermis, dermis, and subcutaneous tissue. The epidermis is the outermost layer, composed of keratinised stratified squamous epithelial cells, while the dermis lies beneath the basement membrane and contains connective tissue. The subcutaneous tissue (hypodermis) is located below the dermis, containing nerve endings and a layer of adipose tissue [1]. Moisturising preparations typically act on the stratum corneum, the outermost layer of the epidermis, to maintain skin hydration. Lack of adequate moisturisation often results in dry and dehydrated skin [2].

The prevalence of dry skin in Indonesia varies across age groups, with approximately 3% in adolescents aged 10–18 years, 12% in adults aged 15–59 years, and up to 80–85% in adults aged 19–59 years [3]. Additionally, 27.9% of women in Indonesia experience oily skin, 28.9% have sensitive skin (prone to redness and irritation), and 37.9% suffer from dry skin. Overall, the prevalence of dry skin in Indonesia ranges between 50–80%, while in other countries such as Brazil, Australia, and Turkey, the prevalence is 35–70% [4]. One common approach to address dry skin is the application of cosmetic moisturising products.

Lotion is one of the most widely used dosage forms for moisturisers, offering a light texture, ease of application, and aesthetic appeal. Common moisturising agents in lotion formulations include glycerin, propylene glycol, and cetyl alcohol [5]. Compared to ointments, lotions are generally preferred by patients and healthcare professionals because they are easier to apply and remove from the skin [6].

However, many synthetic moisturising agents may cause adverse skin reactions, including irritation, allergic responses, dryness, and residue formation [7]. This has led to increased interest in natural alternatives. The butterfly pea flower (*Clitoria ternatea*), known locally as bunga telang, contains secondary metabolites such as alkaloids, flavonoids, tannins, and saponins, which have potential moisturising and antioxidant properties [8]. Moisturisers hydrate the skin primarily by reducing transepidermal water loss (TEWL), thereby improving skin barrier function.

Previous studies have shown the high antioxidant potential of *C. ternatea*. Jayanti et al. (2021) reported that its ethanol extract (70%) exhibited strong antioxidant activity with an IC_{50} value < 50 ppm at 0.1% concentration. Lotion formulations containing 0.5% and 1.0% *C. ternatea* extract demonstrated desirable physicochemical characteristics such as organoleptic properties, homogeneity, spreadability, pH stability, moisture retention, and non-irritancy and were well accepted in consumer testing, with 0.5% extract being the most preferred [9].

Based on these findings, this study was conducted to formulate and evaluate hand and body lotion containing *C. ternatea* extract at varying concentrations and to investigate its physicochemical characteristics and moisturising efficacy.

2. Methods

Research Design

This study employed a true experimental design with a quantitative descriptive approach. The physicochemical evaluations included organoleptic, homogeneity, pH, spreadability, adhesion, and skin moisture tests, using a skin analyzer moisturizer as the primary measurement tool. Statistical analysis was conducted to determine the effect of varying extract concentrations on these parameters.

Materials and Equipment

The materials used in this study included *Clitoria ternatea* (telang) flower extract, ethanol 98%, distilled water, cetyl alcohol, glycerin, liquid paraffin, stearic acid, triethanolamine, propyl paraben, and methyl paraben.

The equipment comprised lotion containers, stirring rods, beaker glasses, mortar and pestle, watch glass, pH meter, analytical balance, skin analyzer moisturizer, homogenizer, stainless steel spoon, drop pipette, spatula, filter paper, aluminium foil, measuring cup, jar, thermometer, stove, blender, sifter, vacuum rotary evaporator, and maceration apparatus.

Formulation of Telang Flower Extract Lotion

Four formulations were prepared: a base lotion without extract (F0) and three formulations containing 1% (F1), 3% (F2), and 5% (F3) *C. ternatea* extract. The composition of each formulation is presented in **Table 1** [10].

Table 1. Formulation of Telang Flower Extract Lotion

Ingredients	Function	F0	F1	F2	F3
Telang Flower Extract	Active substance (humectant)	0	1	3	5
Cetyl Alcohol	Emulsifier	1	1	1	1
Glycerin	Humectant	5	5	5	5
Liquid Paraffin	Emollient	7	7	7	7
Stearic Acid	Emulsifier	4	4	4	4
Triethanolamine	Emulsifier/pH adjuster	1	1	1	1
Propyl Paraben	Preservative	0.02	0.02	0.02	0.02
Methyl Paraben	Preservative	0.1	0.1	0.1	0.1
Distilled Water	Solvent	ad 100 g	ad 100 g	ad 100 g	ad 100 g

Description:
F0 : Formula without extract (Base lotion)
F1 : Formula with 1% concentration of C. ternatea extract

F2 : Formula with 3% concentration of C. ternatea extract
F3 : Formula with 5% concentration of C. ternatea extract

The lotion was prepared using the oil-in-water (O/W) emulsion method. The oil phase (cetyl alcohol, liquid paraffin, stearic acid) was weighed and heated in a water bath at 70–75 °C until melted and homogeneous. The aqueous phase (distilled water, glycerin, preservatives) was also weighed, heated to the same temperature, and stirred until fully dissolved. The aqueous phase was then slowly added to the oil phase with continuous stirring to form an emulsion. When the temperature reached approximately 40 °C, triethanolamine was added to adjust pH and stabilise the emulsion. The lotion was stirred until fully homogeneous and transferred into clean 20 g containers [12].

Extraction of Telang Flower

Dried *C. ternatea* flowers with a moisture content below 10% were milled to pass through a sieve. A total of 500 g of the powder was macerated in 70% ethanol at a ratio of 1:5 for 72 hours in a glass container wrapped with aluminium foil. The filtrate was filtered and concentrated using a rotary evaporator, followed by water bath evaporation to obtain a thick extract.

Phytochemical Screening

Phytochemical tests were conducted according to established methods [7],[11]:
Flavonoids: Addition of acetone, boric acid, oxalic acid, boiling water, and ether; a reddish-purple colour under UV light indicated a positive result.
Saponins: Heating the extract with ethanol, followed by vigorous shaking; persistent foam after addition of 2N HCl indicated a positive result.
Tannins: Addition of $FeCl_3$ reagent; a blackish-green or blue colour indicated a positive result.
Alkaloids: Addition of Dragendorff's reagent; the formation of yellow to light brown precipitate indicated a positive result.

Physicochemical Evaluation

Organoleptic Test: Visual observation of colour, odour, and consistency of the lotion formulation [12].
Homogeneity Test: Microscopic observation to ensure the absence of coarse particles and confirm uniform distribution [12].
pH Measurement: Calibration of pH meter using buffer solutions (pH 4.0 and pH 7.0); 1 g of sample diluted in 10 mL distilled water prior to measurement [13].
Spreadability Test: 0.5 g of sample placed between glass plates, loaded with a 50 g weight; the diameter of the spread was measured [11].
Adhesion Test: 0.5 g of sample placed between two glass slides under a 5-minute load; the time required for separation was recorded [11].
Skin Moisture Test: Measurement before and after application using a skin analyzer at intervals up to 4 hours; moisture categories: very dry (<33%), dry (34–37%), normal (38–42%), moist (43–46%), very moist (>47%) [13].

Data Analysis

Descriptive statistics were used for organoleptic and homogeneity results. Parametric data (pH, spreadability, adhesion, moisture) were tested for normality, followed by one-way ANOVA (SPSS v25). When ANOVA indicated significant differences ($p < 0.05$), a post-hoc multiple comparison test was performed to identify specific differences among formulations. The results of the ANOVA and post-hoc tests are indicated in the tables using superscript letters, where different letters in the same row represent statistically significant differences.

3. Results and Discussion

Extraction Yield

The maceration of *Clitoria ternatea* flowers using 70% ethanol for 72 hours resulted in an extract yield of 42.68%. According to the yield classification, values above 10% are considered good for plant extractions, indicating that the chosen extraction method and solvent system were effective in isolating active compounds from the dried flowers [12]. The high yield obtained in this study may be attributed to the polarity of 70% ethanol, which facilitates the extraction of both polar and moderately non-polar phytochemicals such as flavonoids, tannins, and saponins [7],[11]. Similar findings were reported by Mahardika and Purgiyanti (2024), who achieved high extraction yields of *C. ternatea* using hydroalcoholic solvents, suggesting that ethanol–water mixtures optimise the recovery of bioactive constituents [10].

In the context of lotion formulation, a high extraction yield is advantageous as it ensures sufficient quantities of bioactive compounds for incorporation without requiring excessive raw material input, thus improving cost-effectiveness and feasibility for large-scale production [14]. Furthermore, the efficient extraction of antioxidant-rich compounds supports the intended moisturising function of the final product, as flavonoids and anthocyanins have been shown to protect skin from oxidative stress while enhancing hydration [8],[18].

Phytochemical Screening

Phytochemical screening of the *Clitoria ternatea* extract revealed the presence of alkaloids, flavonoids, saponins, and tannins (**Table 2**). The positive alkaloid reaction was indicated by the formation of a yellow precipitate upon the addition of Dragendorff's reagent, suggesting the presence of nitrogen-containing secondary metabolites with potential biological activity [7],[11]. Flavonoids were detected through a reddish-purple colour observed under UV light after treatment with acetone, boric acid, oxalic acid, boiling water, and ether, consistent with previous findings by Jayanti et al. (2021), who reported strong antioxidant activity of *C. ternatea* extract due to its flavonoid content [9].

Saponins were identified by the formation of persistent foam following heating and vigorous shaking of the extract in ethanol, a property linked to their ability to enhance skin permeability and improve the absorption of active compounds in topical formulations [7],[11]. The presence of tannins was confirmed by a red to purple-black colour after $FeCl_3$ addition, indicating astringent properties that can contribute to tightening the skin and reducing transepidermal water loss (TEWL) [8].

Table 2. Phytochemical Screening Results of *Clitoria ternatea* Extract

No	Phytochemical Compound	Reagent / Method	Positive Reaction Indicator	Observation Result	Description
1	Alkaloids	0.5 mg extract + 5 drops chloroform + 5 drops Mayer reagent	Yellow precipitate	Yellow precipitate	(+)
2	Flavonoids	0.5 mg extract + acetone, boric acid, oxalic acid, boiling water, 10 mL ether	Reddish-purple under UV light	Red-coloured solution	(+)
3	Saponins	0.5 mg extract + 5 mL distilled water, shaken for 30 seconds	Persistent foam (1–10 cm)	Foam and purple-coloured solution	(+)
4	Tannins	1 mg extract + 3 drops $FeCl_3$ 10%	Green, red, purple-blue, or black colour	Red, purple-black solution	(+)

Note: *(+) indicates the presence of the secondary metabolite; (–) indicates absence*

The combination of these phytochemicals supports the multifunctional role of *C. ternatea* extract in cosmetic applications. Flavonoids and anthocyanins function as potent antioxidants, protecting skin cells from oxidative damage, while saponins and tannins contribute to moisturisation and skin barrier protection [14],[18]. These findings are in agreement with Mahardika and Purgiyanti (2024) [10], who emphasised that the synergistic action of multiple phytochemical classes in *C. ternatea* enhances its potential as a natural active ingredient in moisturising formulations.

Physicochemical Properties of the Lotion

The physicochemical evaluation of the *C. ternatea* lotion formulations included organoleptic, homogeneity, pH, spreadability, adhesion, and skin moisture tests. Organoleptic assessment showed a progressive change in colour intensity corresponding to the extract concentration, from white in F0 to dark blue in F3, due to the anthocyanin pigments naturally present in *C. ternatea* [8]. All formulations exhibited a semi-solid consistency, no detectable odour, and were visually homogeneous with no coarse particles observed, confirming uniform mixing and stable emulsion formation [12] (**Table 3**).

Table 3. Organoleptic and Homogeneity Test Results of *C. ternatea* Lotion

Formula	Colour	Odour	Consistency	Homogeneity
F0	White	No odour	Semi-solid	Homogeneous
F1	Light blue	No odour	Semi-solid	Homogeneous
F2	Blue	Odourless	Semi-solid	Homogeneous
F3	Dark blue	Odourless	Semi-solid	Homogeneous

Note: All formulations were semi-solid and visually homogeneous, with no observable coarse particles.

The pH values of all formulations ranged from 6.79 ± 0.04 to 7.84 ± 0.01, which met the acceptable range for topical cosmetics (4.5–8.0) as stated in SNI 16-3499-1996 [15]. ANOVA analysis indicated significant differences among formulations ($p < 0.001$), with F3 exhibiting the lowest pH, likely influenced by phenolic acids present in the extract [16].

Spreadability values varied between 6.50 ± 0.50 cm and 8.70 ± 0.60 cm, with significant differences ($p = 0.017$). Formulations exceeding the optimal range of 5–7 cm [11] may have lower viscosity, potentially due to the hydrophilic effect of triethanolamine, which affects oil–water phase binding [18].

Adhesion times ranged from 3.47 ± 0.83 s to 4.11 ± 0.69 s, showing no significant differences ($p = 0.419$) and meeting the standard range of 2–300 s [11],

Skin moisture levels improved notably in extract-containing formulations, with F1–F3 classified as "very moist" (>47%) compared to F0 (45.38 ± 2.05%). ANOVA results showed significant differences ($p = 0.037$), confirming that flavonoids and anthocyanins in *C. ternatea* reduce transepidermal water loss and enhance skin hydration [18]. Overall, the results demonstrate that incorporating *C. ternatea* extract enhances moisturising efficacy while maintaining physicochemical properties within acceptable limits (**Table 4**).

Table 4. Summary of Physicochemical Parameters of *C. ternatea* Lotion

Parameter	F0	F1	F2	F3	Acceptable Range [11],[15],[18]
pH	7.84 ± 0.01^{a}	7.49 ± 0.10^{b}	7.55 ± 0.08^{b}	6.79 ± 0.04^{c}	4.5–8.0
Spreadability (cm)	8.00 ± 1.00^{ab}	6.50 ± 0.50^{c}	8.70 ± 0.60^{a}	8.20 ± 0.30^{a}	5–7 cm
Adhesion (s)	4.11 ± 0.69^{a}	3.47 ± 0.83^{a}	3.58 ± 0.51^{a}	3.78 ± 0.46^{a}	2–300 s
Moisture (%)	45.38 ± 2.05^{a}	47.70 ± 0.58^{b}	47.07 ± 0.02^{b}	46.71 ± 0.44^{ab}	>47% = very moist

Note: Values are mean ± SD (n=3). Different superscript letters in the same row indicate statistically significant differences among formulations (p < 0.05) as determined by one-way ANOVA followed by post-hoc multiple comparison test, in accordance with the statistical analysis described in the Methods section.

Statistical Analysis

Statistical analysis using one-way ANOVA was conducted to determine whether the differences observed among formulations were statistically significant. The results showed that pH ($p < 0.001$), spreadability ($p = 0.017$), and moisture content ($p = 0.037$) differed significantly among formulations, while adhesion ($p = 0.419$) did not demonstrate a statistically significant difference (**Table 4**).

The significant variation in pH among formulations suggests that the concentration of *C. ternatea* extract influences the acidity of the lotion, with higher concentrations lowering pH due to phenolic and flavonoid components [16]. This aligns with previous studies showing that botanical extracts rich in phenolics tend to acidify formulations, which can benefit skin barrier function when maintained within the safe pH range [17].

For spreadability, significant differences were observed particularly between F1 and the higher spreadability formulations (F0, F2, F3). This may be attributed to differences in viscosity influenced by both extract concentration and the emulsifying system [18]. Formulations exceeding the optimal spreadability range (5–7 cm) [11] may offer easier application but could reduce product retention on the skin surface.

Moisture content analysis revealed significant improvement in extract-containing formulations compared to the base lotion. Formulations F1 and F2 achieved the highest moisture values (>47%), placing them in the "very moist" category [18]. This effect is likely due to the hygroscopic and antioxidant properties of flavonoids and anthocyanins, which reduce transepidermal water loss and enhance hydration [8].

In contrast, adhesion did not significantly differ among formulations ($p > 0.05$), indicating that extract concentration within the tested range did not substantially affect the lotion's ability to adhere to the skin. This stability in adhesion performance ensures consistent contact time for active compound delivery, which is favourable for product usability [11].

Overall, the statistical outcomes confirm that the addition of *C. ternatea* extract influences several key physicochemical properties particularly pH, spreadability, and moisturising capacity while maintaining acceptable adhesion performance. These findings provide a strong basis for optimising extract concentration to balance product aesthetics, stability, and efficacy in future formulations.

Implications for Product Development

The findings of this study have significant implications for the development of herbal-based moisturising products. The incorporation of *C. ternatea* extract at concentrations between 1–5% enhanced skin moisture to the very moist category (>47%), while maintaining acceptable pH, spreadability, and adhesion within standard cosmetic formulation requirements [11],[15]. This demonstrates that the extract can be effectively used as an active ingredient in lotion formulations without compromising product stability or user comfort.

The colour variation produced by the anthocyanin content offers an additional marketing advantage, as naturally derived pigments are increasingly valued in the cosmetic industry for their clean-label appeal [8]. Moreover, the presence of flavonoids, tannins, and saponins contributes not only to moisturising efficacy but also to potential antioxidant and protective skin effects, aligning with the growing consumer demand for multifunctional cosmetic products [9],[18].

From a formulation perspective, the optimised spreadability and stable adhesion ensure ease of application and adequate skin contact time for active compound absorption. These properties are crucial for consumer acceptability, which is a key determinant of product success in the market [14]. Furthermore, the use of *C. ternatea* extract supports the current global trend toward sustainable and natural cosmetic formulations, potentially appealing to eco-conscious consumers and niche herbal skincare markets [16].

To advance product development, future work should focus on long-term stability testing, in vivo safety and efficacy studies, and consumer acceptability trials. Such studies will provide a more comprehensive understanding of the formulation's performance and support regulatory compliance for commercial launch.

Although the *C. ternatea* extract lotion demonstrated acceptable physicochemical characteristics and significant moisturising effects, this study had several limitations. First, the research did not include long-term stability testing, which is necessary to evaluate physical, chemical, and microbiological stability during storage [15]. Second, no in vivo safety assessments, such as skin irritation or sensitisation tests, were performed, which are essential to confirm product safety for regular topical use [14]. Third, the antioxidant activity of the final lotion was not evaluated, despite the known antioxidant potential of *C. ternatea* extract [9]. Lastly, the study was conducted at a laboratory scale without consumer acceptability testing, which could provide valuable insights into sensory attributes, user satisfaction, and market readiness [18].

4. Conclusion

This study demonstrated that hand and body lotion formulations containing *Clitoria ternatea* extract at concentrations of 1–5% exhibited acceptable physicochemical characteristics and significant moisturising efficacy. All formulations met the standard requirements for topical products in terms of pH, homogeneity, and consistency, with extract-containing formulations achieving skin moisture levels in the "very moist" category (>47%). Statistical analysis revealed significant differences in pH, spreadability, and moisture among formulations ($p < 0.05$), while adhesion remained stable across all formulations.

The results confirm that *C. ternatea* extract can be effectively incorporated as a natural active ingredient in moisturising lotion formulations without compromising product stability or user comfort. Future studies are recommended to include long-term stability testing, in vivo safety and efficacy assessments, antioxidant activity evaluation of the final formulation, and consumer acceptability studies to support commercial application and regulatory compliance.

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Conflict of Interest:

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

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