Acta. Chim. Asiana., 9(2), 956-964
e-ISSN/p-ISSN 2550-0503/2550-049x
Available online at: www.aca.unram.ac.id

RESEARCH PAPER

Formulation and physical quality test of Taro leaf extract hand cream preparation (*Colocasia esculenta* L.)

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DOI: https://doi.org/10.29303/aca.v9i2.320

Article info
Received: 22/08/2026
Revised: 02/10/2026
Accepted: 05/11/2026
Available online: 11/11/2026

Abstract: Hand skin that is often exposed to hand washing activities and excessive use of hand sanitizers is prone to dryness, so it requires a safe and effective moisturizing preparation. Taro leaves (*Colocasia esculenta* L.) contain secondary metabolite compounds such as flavonoids, alkaloids, saponins, tannins, and steroids that have the potential to be used as active ingredients in hand cream preparations. This study aims to formulate and evaluate the physical quality of taro leaf extract hand cream preparations and determine the best formula. The study used laboratory experimental methods with extraction by maceration and remaceration using 96% ethanol. The *hand cream preparation* is formulated in three variations of extract concentration, namely F1 (2%), F2 (4%), and F3 (6%), and is compared with negative control (F0) and positive control (commercial synthetic hand cream). The physical quality evaluation includes organoleptic tests, emulsion type, homogeneity, pH, dispersibility, adhesion, and viscosity, which are then statistically analyzed using the One Way ANOVA or Kruskal–Wallis test. The results showed that taro leaf extract had a yield of 17.5% and positively contained alkaloids, flavonoids, saponins, tannins, and triterpenoids. The entire formula meets the requirements of organoleptic, homogeneity, emulsion type (M/A), pH, dispersability, and adhesion, while the viscosity test only meets the requirements on F2 and F3. Statistical analysis showed that variations in extract concentrations had a significant effect on pH, dispersibility, adhesion, and viscosity ($p<0.05$). The F2 formula (4%) is the best formula because it meets all physical quality parameters and has the most optimal physical characteristics, comparable to commercial positive controls. These findings confirm the potential of taro leaf extract as a natural active ingredient in the development of hand skin moisturizing cosmetic preparations, while opening up further research opportunities regarding the biological activity and long-term stability of the preparation.

Keywords: Hand cream, taro leaves, *Colocasia esculenta* L., formulation, physical quality.

INTRODUCTION

The skin is the outermost organ of the human body which plays an important role in protecting the body from environmental influences. The skin is categorized as healthy if the outer layer contains more than 10% moisture; On the other hand, dry skin is characterized by a minimal layer of surface fat that loses elasticity, becomes stiff, and gives rise to fine lines [16]. In the hands, this condition not only affects appearance but also comfort and quality of life, especially in individuals who wash their hands frequently or use *hand sanitizer* excessively. Decreased moisture content in the stratum corneum leads to changes in lipid structure and increased *transepidermal water loss* (TEWL), resulting in skin appearing rough and dry and requiring effective moisturizing treatment [21].

Epidemiological data show the magnitude of the prevalence of this problem. Studies in adult populations in Europe reported an annual incidence of hand eczema ranging from 6.5–17.5%, with a long-term prevalence of 15.8% in young adults [8]. In Thailand, 20.87% of respondents experienced hand dermatitis in health practices [23], while meta-analyses in medical personnel reported a lifetime prevalence of about 33.4% and an annual prevalence of 27.4% [26]. *The World Health Organization* through the *WHO Guidelines on Hand Hygiene in Health Care* also emphasizes the importance of moisturizers (*lotions*/*creams*) as a support for hand hygiene practices, especially for medical personnel,

because *hand creams* help restore lost moisture and lipids in the stratum corneum [25]. In Indonesia, a study of the elderly in Jakarta found that the frequency of using *hand sanitizer* ≥10 times/day and washing hands >10 times/day correlated with low skin moisture [3], and a recent local survey noted that the majority of respondents had dry to very dry skin moisture [18].

Various commercial *hand creams* generally contain synthetic ingredients such as emollients, humectants, preservatives, and emulsifiers designed for physical stability and user acceptance [21], but components such as perfumes, phenoxyethanol, and tocopherol have been detected as allergens in various products in circulation [9]. This condition encourages interest in developing *hand creams* made from natural ingredients that are safer and more environmentally friendly. Previous research has shown that papaya peel extract (*Carica papaya* L.) and yellow sweet potato peel (*Ipomoea batatas* L.) can be formulated into *a hand cream* with physical quality that meets the standard [1], while pineapple peel extract (*Ananas comosus* (L.) Merr.) provides a moisturizing effect as well as antioxidant and anti-aging potential [22].

Taro leaves (*Colocasia esculenta* L.) were chosen as an alternative active ingredient because they contain bioactive compounds such as flavonoids, tannins, saponins, and polyphenols that have the potential to be antioxidants and support skin health [3]. Despite its potentially bioactive properties, raw taro leaves are known to cause irritation due to raphide-shaped calcium oxalate crystals; The extraction and heating process can reduce the oxalate content so that the extract becomes safer to use in cosmetic formulations [5]. The functional properties of polysaccharides, including taro leaf mucilage, have also been reported to act as natural emulsifier, thickening and stabilizing agents with pseudoplastic behavior appropriate for cream or gel preparations [13]. The use of taro leaves in topical preparations has been reported in the form of burn healing gels [6] and antibacterial emulgels [24], but its development specifically as *a hand cream* with a comprehensive physical quality evaluation is still limited. The morphological characteristics and overall appearance of the plant are shown in Figure 1.



Figure 1. Fresh taro leaves (*Colocasia esculenta* L.)

Physical quality evaluation is a crucial stage in the formulation *of natural hand creams* to ensure product quality, stability, and safety, including pH, homogeneity, viscosity, dispersibility, and organoleptic aspects [1]. Based on this description, this study aims to: (1) determine the results of the evaluation of physical quality (organoleptis, emulsion type, homogeneity, pH, viscosity, dispersibility, and adhesion) of taro leaf extract *hand cream* preparations; (2) determine the best formulation among F1 (2%), F2 (4%), and F3 (6%); (3) to know the difference in physical quality between the test preparation, negative control, and positive control; and (4) comparing the physical quality *of taro leaf extract* hand cream with commercially synthesized *hand cream*. This research is expected to enrich the scientific literature on the formulation of natural ingredients for hand skin care while supporting the use of Indonesia's local natural resources.

MATERIALS AND METHODS

Research Design. The study used a laboratory experimental method with *a post-test only control group design*, where physical quality testing was carried out after *the hand cream* was formulated, then compared with negative control and positive control (commercial synthetic *hand cream*). The research was carried out in March-April 2026 at the Integrated Laboratory of UIN Mataram (plant determination), the Biochemistry Laboratory of Bumigora University (phytochemical extraction and screening), the Laboratory of Pharmaceutical Preparation Technology (formulation and physical quality test), and the Advanced Physics Laboratory of the University of Mataram (viscosity test).

Population and Sample. The study population is taro leaves from Tembeng Putik Village, Wanasaba District, East Lombok. Inclusion criteria include fresh leaves that are light green to dark green, come from correctly identified plants, are in good condition, and are harvested in the morning; Exclusion criteria include leaves with mechanical/torn damage >30%, unnatural wilting or yellowing, and contaminated with fungi, parasites, or chemicals.

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Tools and Materials. The tools used include analytical scales, glass jars, blenders, strainers and filter paper, chemical cups, measuring cups, porcelain cups, mortar-stampers, water baths, pH meters, 40 mesh sieves, hot plates, *rotary evaporators*, dispersion and adhesion test kits, and *Brookfield viscometers*. The ingredients used include aquadest, 96% ethanol, taro leaf extract, HCl 2N, Mayer and Dragendorff reagents, Mg powder, $FeCl_3$ 1%, anhydrous acetic acid, concentrated sulfuric acid, methylene blue, stearic acid, cetyl alcohol, VCO, glycerin, methyl paraben, propyl paraben, TEA, lavender fragrance, and *commercial synthetic hand cream* as positive control.

Work Procedures. Plant determination was carried out to ensure the botanical identity of taro leaves as *Colocasia esculenta* L. Simplisia is made through wet sorting, washing, stirring, and drying in the sun with a black cloth cover, then pollinated and sifted (mesh 40). Extraction was carried out by maceration using 1,500 mL of 96% ethanol against 200 grams of simplicia (ratio 1:10) for 3×24 hours in a closed container, followed by residue remaceration with 500 mL of 96% ethanol for 2×24 hours. The filtrate is combined and concentrated with a *rotary evaporator*, then the yield is calculated using the formula:

$$\text{Extraction Yield} = \frac{\text{(Weight of Dried Extract) (gram)}}{\text{(Weight of Dried Plant Material) (gram)}} \times 100\%$$

Phytochemical screening was performed on viscous extracts for the identification of alkaloids (Mayer and Dragendorff reagents), flavonoids (Mg + concentrated HCl), saponins (foam test, HCl 2N) [11], tannins ($FeCl_3$ 1%) [17], as well as terpenoids/steroids (Liebermann–Burchard test) [19]. The *hand cream formulation* is made in four variations: F0 (negative control, no extract), F1 (2% extract), F2 (4% extract), and F3 (6% extract), with a composition of 10% stearic acid (emulsifier), 8% cetyl alcohol (stabilizer), VCO 5% (moisturizer), glycerin 10% (humectant), methyl paraben 0.18% and propyl paraben 0.02% (preservative), TEA 2% (emulsifier), lavender qs (fragrance), and aquadest *ad* 100% (solvent) see Table 1. Manufacture is carried out by emulsification method: the oil phase (stearic acid, VCO, propyl paraben, cetyl alcohol) and the water phase (methyl paraben, TEA, glycerin, aquadest) are heated separately at ±70 °C, mixed in a hot mortar until an emulsion is formed, then lavender extracts and fragrances are added. The composition of the hand cream formulations containing taro leaf extract, including the concentration of each ingredient, is presented in Table 1.

Table 1. Taro Leaf Extract *Hand Cream* Formula

Ingredients	F0	F1	F2	F3	Remarks
Taro leaf extract	–	2%	4%	6%	Active substances
Stearic acid	10%	10%	10%	10%	Emulsifier
Acetyl alcohol	8%	8%	8%	8%	Stabilizer
VCO	5%	5%	5%	5%	Moisturizer
Glycerin	10%	10%	10%	10%	Hufixan
Methyl Paraben	0,18%	0,18%	0,18%	0,18%	Preservatives
Propyl paraben	0,02%	0,02%	0,02%	0,02%	Preservatives
TEA	2%	2%	2%	2%	Emulsifier
Lavender	QS	QS	QS	QS	Aroma
Aquadest	Add 100%	Add 100%	Add 100%	Add 100%	Solvents

Physical quality evaluation was conducted on F0–F3 and positive control (KP), including: (1) *organoleptic tests* observation of color, smell, shape, and taste when applied; (2) *emulsion type test* addition of methylene blue at 0.5 g of preparation, type M/A when the color is evenly distributed and A/M when blue spots appear; (3) *homogeneity test*observation of 1 g of the preparation between two glass objects under light; (4) *pH test* measurement with a digital pH meter on a solution of 1 g of preparation in 100 mL aquadest, topical pH requirement 4.5–7 according to SNI 16-4399-1996; (5) *dispersion test* 1 g of the preparation is loaded with 100 g for 1 minute, 5–7 cm requirement; (6) *viscosity test* 25 g of the preparation was measured with *a Brookfield* spindle viscometer number 64 at 12 rpm, a requirement of 2,000–50,000

cPs; and (7) *an adhesion test* the time of separation of two glass objects after a standard load of pressure for 5 minutes, a requirement of ≥4 seconds to 300 seconds.

Data Analysis. Organoleptic and homogeneity data were analyzed descriptively. Quantitative data on pH, viscosity, dispersability, and adhesion were calculated on average and compared to topical quality standards, then statistically analyzed using the One Way ANOVA test (normal and homogeneous distributed data) or the Kruskal–Wallis test (non-normally distributed data) to assess the differences between formulas. The best formula is determined based on conformity with physical quality standards and the overall stability of the stock.

RESULTS AND DISCUSSION

Plant determination. The results of the determination at the Integrated Laboratory of UIN Mataram confirmed that the sample used was *Colocasia esculenta* L. from the *Araceae family*, ensuring the authenticity of the research raw materials.

Extraction Results. The extraction of 200 grams of simplicia powder yielded 35 grams of thick extract with a yield of 17.5% (**Table 2**), meeting the requirements of the Indonesian Herbal Pharmacopoeia Edition II which is no less than 7.8% [10]. This high yield value is thought to be related to the ability of 96% ethanol to optimally dissolve various secondary metabolite compounds, in line with the principle that the higher the yield, the greater the number of components extracted from the simplicia to the solvent [4]. The extraction process resulted in a measurable extract yield, which was calculated based on the ratio of the obtained extract mass to the initial mass of the plant material. The results are presented in Table 2.

Table 2. Extract yield calculation results

Sample	Weight of simplisia powder	Weight of the thick extract	Yields
Taro leaves	200 grams	35 grams	17,5%

Phytochemical screening. Screening results showed that the taro leaf extract was positive for alkaloids (orange deposits with Dragendorff; yellowish-white deposits with Mayer), flavonoids (yellow discoloration with concentrated Mg/HCl), saponins (stable foams 1–10 cm), tannins (blackish-green with $FeCl_3$), and steroids/triterpenoids (green color in the Liebermann Burchard test). The flavonoid content is known to act as antioxidants that protect the skin from free radical damage [2], while tannins provide astringent activity and saponins provide antibacterial activity that supports skin surface cleanliness [15]. The presence of alkaloids and steroids also supports antibacterial and anti-inflammatory activity [12], so that overall this phytochemical profile strengthens the potential of taro leaf extract as a functional active ingredient in *hand cream* preparations.

Preparation Making. The entire formula is successfully made with a soft texture, lavender scent, and a color that is more intense as the concentration of the extract increases (F1 light green; F2 and F3 green are more concentrated). No phase separation was found, indicating that the emulsion system formed was visually stable and ready to proceed to the physical quality evaluation stage. The physical appearance of the hand cream formulations, including F0, F1, F2, and F3, was observed to assess their visual characteristics. The results are presented in Figure 2.



Figure 2. Physical appearance of hand cream formulations F0, F1, F2, and F3

Organoleptic and Emulsion Type Tests. The entire formula has a soft texture with scents of lavender (F0–F3) and *green tea* (CP); the main difference lies in the intensity of the green color that increases with the concentration of the extract (**Table 3**). The emulsion-type test using methylene blue showed that the entire formula (F0, F1, F2, F3, KP) was oil-in-water (M/A) (**Figure 3**) the blue color is evenly dispersed which corresponds to the ideal characteristics of *hand creams* because they are easy to flatten, not over-oiled, and easy to clean [14]. The emulsion type of the hand cream formulations was evaluated using the methylene blue staining method, and the results are presented in Figure 3.

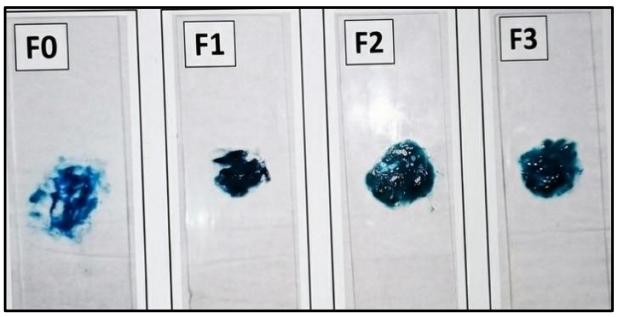


Figure 3. Emulsion type test results using methylene blue

The organoleptic evaluation was conducted to assess the physical characteristics of the hand cream formulations, including color, odor, and consistency, which are important quality attributes that may influence the acceptability and stability of the preparation. In addition, the emulsion type was determined to characterize the dispersion system formed in each formulation and to confirm the consistency of the hand cream preparation. The evaluation was performed on the control formulation (F0) and the formulations containing taro leaf extract (F1, F2, and F3). The results of the organoleptic evaluation and emulsion type assessment for all hand cream formulations are presented in Table 3.

Table 3. Organoleptic test results and emulsion types

Formula	Texture	Color	Aroma	Emulsion type
F0	Soft	White	Lavender	M/A
F1	Soft	Light green	Lavender	M/A
F2	Soft	Green	Lavender	M/A
F3	Soft	Green	Lavender	M/A
CP	Soft	White	Green Tea	M/A

Homogeneity Test. The entire formula indicates a homogeneous preparation with no coarse particles or lumps, indicating an even dispersion of the constituent ingredients (including extracts) in the cream base (**Figure 4**) an important parameter to guarantee uniformity of the active ingredient content in each part of the preparation. The homogeneity test was conducted to evaluate the uniformity of the hand cream formulations and to determine whether the active extract and other formulation components were evenly distributed throughout the preparation. Homogeneity is an important physical characteristic of topical preparations because a uniform formulation ensures consistent composition and supports the proper distribution of the active ingredients in each application. The homogeneity of the control formulation (F0) and the hand cream formulations containing taro leaf extract (F1, F2, and F3) was evaluated by observing the presence or absence of coarse particles, lumps, or phase separation in the preparations. The results of the homogeneity test for all formulations are presented in Figure 4.

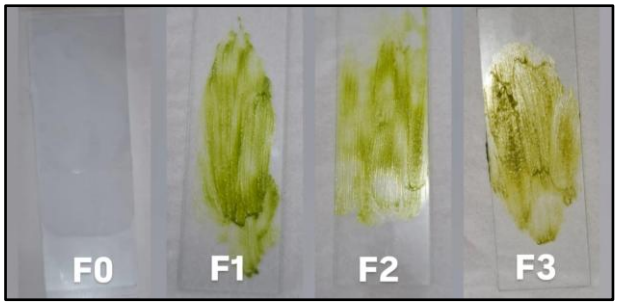


Figure 4. Results of homogeneity test

pH test. The average pH value decreases as the concentration of the extract increases: F0 7.6; F1 6.7; F2 5.7; F3 5.8; and KP 5.0 (**Table 4**), thought to be due to the slightly acidic nature of the secondary metabolites in the extract. All extracted formulas (F1–F3) meet the topical pH requirement of 4.5–7 [7], making them safe for use on the skin without the risk of irritation due to pH that is too acidic or dryness due to pH that is too alkaline. The pH of the hand cream formulations was evaluated to determine their suitability for topical application and to assess the effect of taro leaf extract incorporation on the acidity or alkalinity of the preparations. The pH is an important quality parameter for topical formulations because preparations with inappropriate pH values may cause skin irritation or discomfort, whereas a pH compatible with the skin can contribute to better tolerability and user acceptability. The pH evaluation was performed on the control formulation (F0) and the hand cream formulations containing taro leaf extract

(F1, F2, and F3). The results of the pH evaluation for all formulations are presented in Table 4.

Table 4. pH Test Results

Formula	Replication I	Replication II	Replication III	Average
F0	8	7,8	7	7,6
F1	7	6,8	6,5	6,7
F2	6	5,7	5,5	5,7
F3	6	5,9	5,7	5,8
CP	5	5,2	5	5,0

Dispersion Test. The dispersion values range from 5.6–7.1 cm (**Table 5**), with F1 (7.1 cm) highest and F3 (5.7 cm) the lowest, in line with the viscosity–dispersion relationship: the higher the viscosity, the smaller the dispersion. All formulas are within the requirement range of 5–7 cm, supporting the convenience of application and release of the active substance to the skin [1].

Table 5. Dispersion Test Results (cm)

Formula	Replication I	Replication II	Replication III	Average
F0	6	6,1	6,2	6,1
F1	7	7,2	7,2	7,1
F2	6	6	6,1	6,0
F3	5,5	5,8	5,8	5,7
CP	5,8	5,5	5,6	5,6

Adhesion Test. The adhesion value ranges from 4.15–10.62 seconds (**Table 6**), all of which meet the 4–300 second requirements. Adhesion is positively correlated with viscositythicker preparations take longer to detach from the surfaceso the contact between the active ingredient and the skin is more optimal [20].

Table 6. Adhesion test results (seconds)

Formula	Replication I	Replication II	Replication III	Average
F0	10,21	10,50	11,15	10,62
F1	4,16	4,10	4,20	4,15
F2	5,10	5,14	5,21	5,15
F3	5,05	5,11	5,18	5,11
CP	5,20	5,17	5,21	15,19

Viscosity Test. The viscosities of F1, F2, F3, and KP are qualified for 2,000–50,000 cPs, while F0 is not qualified because it is too thick due to lack of aquadest during formulation (**Table 7**). The difference in viscosity between formulas confirms that variations in ingredient concentrations affect the consistency of the preparationhigher viscosity is associated with lower dispersibility, while too low viscosity risks lowering stability during storage.

Table 7. Viscosity test results (mPa.s)

Formula	I	II	III	IV	V	Average
F0	158.600	158.000	157.399	157.200	157.800	157.799,8
F1	55.100	55.400	55.400	55.500	55.500	55.380
F2	40.200	40.200	40.300	40.200	40.100	40.200
F3	28.400	28.800	28.900	28.600	28.800	28.700
CP	50.000	49.900	49.800	50.100	49.900	49.940

Statistical Analysis. The results of the analysis showed that the variation in the concentration of taro leaf extract had a significant influence on all quantitative parameters tested, with significance values of pH (0.012), dispersion (0.014), adhesion (0.000), and viscosity (0.009) a total of <0.05. Based on all parameters, the F2 formula (4%) exhibits the most optimal characteristics: pH 5.7 (according to skin pH), dispersion power of 6.0 cm, adhesion of 5.15 seconds, and viscosity of 40,200 mPa.s, all of which are within the range of physical quality standards of topical cream preparations and close to commercial positive control profiles.

CONCLUSION

All taro leaf extract hand cream *formulas* meet physical quality requirements including organoleptic, emulsion type, homogeneity, pH, dispersibility, and adhesion, but in the viscosity test only F2 (4%) and F3 (6%) meet the range of requirements. The best formula is F2 (4%) because it meets all physical quality parameters with the most optimal characteristics. There was a significant difference in physical quality between taro leaf extract preparations, negative controls, and positive controls ($p<0.05$). The physical quality *of taro leaf extract hand cream* is comparable to that of commercial synthetic *hand cream*, indicated by the pH value, dispersibility, adhesion, and viscosity that are close to positive control and meet the physical quality requirements of the cream preparation. These findings confirm the potential of taro leaf extract as a natural active ingredient in the development of *hand cream* formulations. Further research is recommended to test biological activity (antioxidants, antibacterial, skin moisture), formula optimization, and stability and irritation tests to obtain a more stable and safe preparation for long-term use.

ACKNOWLEDGEMENTS

The author would like to thank to Bumigora University for the support of laboratory facilities, as well as to the research supervisor for his direction and guidance during the implementation of this research.

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