Sheet Mask Bintangur (Calophyllum inophyllum L.)

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Track Record Article

Revised: 01 August 2026
Accepted: 28 September 2026
Published: 30 September 2026

How to cite :
Faisal, A. P., & Nurpermatasari, A. (2026). Sheet Mask Bintangur (Calophyllum inophyllum L.). *Contagion : Scientific Periodical of Public Health and Coastal Health*, 8(3), 549–559.

Abstract

Environmental exposure, particularly ultraviolet radiation and pollution, can promote oxidative stress in the skin and contribute to premature skin aging, highlighting the need for safe natural antioxidants in preventive skin care. Bintangur (Calophyllum inophyllum L.) leaves contain bioactive compounds with potential antioxidant properties and may be developed as a botanical ingredient for topical preparations. This study aimed to formulate and evaluate the physical characteristics and stability of Bintangur leaf ethanol extract in sheet mask preparations. Bintangur leaves were extracted by maceration using 96% ethanol and formulated into sheet masks at concentrations of 0.5% (FI), 1.0% (FII), and 1.5% (FIII), with F0 serving as a negative control. The formulations were evaluated for organoleptic properties, homogeneity, pH, viscosity, skin irritation, and four-week stability. All formulations remained homogeneous, with initial pH values ranging from 6.70 to 7.42 and mean viscosities ranging from 533.33 to 621.33 cP. During four weeks of storage, all formulations maintained homogeneity and acceptable pH values, although slight brownish discoloration occurred in extract-containing formulations. No irritation was observed among the 10 panelists. FI (0.5%) showed the most favorable overall stability, particularly the smallest pH change during storage. These findings support further investigation of Bintangur leaf extract sheet masks as a locally sourced botanical formulation for preventive skin care.

Keywords: Bintangur, Calophyllum inophyllum L., sheet mask, formulation

INTRODUCTION

Skin health is increasingly affected by environmental stressors, particularly ultraviolet (UV) radiation and air pollution, which contribute to the generation of reactive oxygen species (ROS) and oxidative stress. The global burden of skin and subcutaneous diseases remains substantial. Based on the Global Burden of Disease 2021 estimates, approximately 4.69 billion incident cases and 2.03 billion prevalent cases of skin and subcutaneous diseases occurred worldwide, accounting for approximately 41.94 million disability-adjusted life years (DALYs) (Li et al., 2026). Environmental exposure is increasingly recognized as an important contributor to impaired skin health. UV radiation promotes oxidative stress, DNA damage, collagen degradation, and alterations in extracellular matrix homeostasis, which contribute to premature skin aging and deterioration of the skin barrier (Hooda et al., 2023). Airborne pollutants, particularly particulate matter, can also induce ROS accumulation and oxidative stress and disrupt skin barrier function (Diao et al., 2021). These mechanisms support the need for safe topical antioxidant approaches capable of complementing the skin's endogenous antioxidant defense.

This concern is particularly relevant to tropical countries such as Indonesia, where environmental exposure provides a rationale for investigating locally available botanical resources as potential sources of topical antioxidants. Rather than biodiversity alone, the pharmacological value of Indonesian medicinal plants should be considered according to their bioactive constituents and potential applications in preventive skin care. One promising species is Bintangur (*Calophyllum inophyllum* L.), a pantropical plant belonging to the Calophyllaceae family. *C. inophyllum* contains diverse secondary metabolites, including phenolic compounds, polyphenols, flavonoids, xanthones, coumarins, terpenoids, and other bioactive constituents associated with antioxidant, anti-inflammatory, antimicrobial, and wound-healing activities (Ferdosh et al., 2024). These pharmacological properties provide a more specific basis for investigating Bintangur as a botanical ingredient for topical skin-care formulations.

Recent evidence has strengthened the biological rationale for the use of *C. inophyllum* in skin-related applications. Chambon et al. (2023) investigated medicinal plants traditionally used for skin care and demonstrated antioxidant properties of *C. inophyllum* extracts through total phenolic content, DPPH radical-scavenging, and ferric reducing antioxidant power assays, together with metabolomic characterization of antioxidant constituents (Chambon et al., 2023). A recent review also reported that different parts of *C. inophyllum* contain pharmacologically important constituents, including flavonoids, coumarins, fatty acids, and xanthones, with potential antioxidant, anti-inflammatory, wound-healing, and antiaging properties relevant to pharmaceutical and cosmetic applications (Ferdosh et al., 2024). In Indonesia, Bintangur leaves have also been reported to contain flavonoids, alkaloids, tannins, saponins, steroids, and terpenoids, while previous experimental evidence has demonstrated the antioxidant activity of Bintangur leaves against DPPH free radicals. These findings indicate that Bintangur leaves represent a potentially valuable source of natural antioxidant compounds for topical formulation. The existing manuscript also identifies these phytochemical groups and their antioxidant potential.

The biological activity of a plant extract alone, however, does not ensure its suitability as a topical product. The delivery system must maintain acceptable physicochemical characteristics and stability while facilitating practical application to the skin. Sheet masks are topical delivery systems in which an essence containing active ingredients is retained within a sheet substrate, allowing direct and relatively uniform contact with the facial skin. Compared with conventional semisolid preparations, this dosage form offers practical application and prolonged contact of the formulation with the skin surface. The original formulation in this study uses Bintangur leaf ethanol extract at concentrations of 0.5%, 1.0%, and 1.5%,

incorporated into a sheet mask essence containing humectants and other formulation components.

Previous studies have investigated *C. inophyllum* and other botanical extracts for their antioxidant properties and incorporation into several topical preparations. However, evidence remains limited regarding the incorporation of Bintangur leaf ethanol extract into a sheet mask delivery system, particularly regarding how different extract concentrations influence the physicochemical characteristics and short-term stability of the formulation. This distinction is relevant because a sheet mask has formulation requirements that differ from conventional creams or peel-off gels, particularly in terms of essence homogeneity, viscosity, pH, compatibility with the sheet substrate, and stability during storage. Therefore, evaluating Bintangur leaf extract in a sheet mask provides a formulation-specific contribution rather than merely replicating previously reported topical preparations.

Accordingly, this study aimed to formulate sheet masks containing 0.5%, 1.0%, and 1.5% ethanol extract of Bintangur (*Calophyllum inophyllum* L.) leaves and to evaluate their physical characteristics and four-week stability based on organoleptic properties, homogeneity, pH, viscosity, and skin irritation parameters. The study was designed to determine whether variations in Bintangur leaf extract concentration could produce sheet mask formulations with acceptable physical quality and stability for further development as a botanical topical preparation.

METHODS

This study was an experimental laboratory study evaluating sheet mask formulations containing ethanol extract of Bintangur (*Calophyllum inophyllum* L.) leaves. The plant was identified at the Medanense Herbarium Laboratory, Universitas Sumatera Utara, Indonesia. A total of 500 g of dried leaf powder was macerated with 96% ethanol for five days with periodic stirring. The filtrate was concentrated using a rotary evaporator at 60°C followed by a water bath at 50°C, yielding 105.60 g of thick extract with an extraction yield of 21.12%.

Four sheet mask formulations were prepared: F0 without extract (negative control), FI containing 0.5% extract, FII containing 1.0% extract, and FIII containing 1.5% extract. Each 15-g formulation contained PEG-40 hydrogenated castor oil (0.750 g), glycerin (2.250 g), butylene glycol (2.250 g), sodium polyacrylate (0.750 g), 70% ethanol (0.450 g), nipagin (0.045 g), perfume, and purified water *q.s.* to 15 g. The extract was incorporated into the prepared essence base, homogenized, applied to the mask sheet, packed in individual foil pouches, and sealed.

The physical characteristics of each formulation were evaluated through organoleptic, homogeneity, pH, and viscosity tests. Organoleptic evaluation included color, appearance, and aroma, while homogeneity was assessed based on the absence of visible coarse particles. The pH was measured using a pH meter, and viscosity was determined in triplicate using a Brookfield viscometer with spindle No. 3 at 30 rpm.

A skin irritation test was conducted on 10 panelists by applying the formulation to the skin behind the ear for 6–12 hours and observing any signs of local irritation following application. Eligible panelists were healthy individuals aged 20–30 years who voluntarily agreed to participate and provided written informed consent. The formulations were also subjected to a four-week short-term real-time stability evaluation at room temperature, with weekly assessments of organoleptic characteristics, homogeneity, and pH.

The study received ethical approval from the Health Research Ethics Committee of Poltekkes Kemenkes Medan (No. 01.26.748/KEPK/POLTEKKES KEMENKES MEDAN 2025**).**

RESULTS

The results of plant determination carried out at the Medanense Herbarium Laboratory, University of North Sumatra, showed that the bintangur leaves studied belonged to the Calophyllum species. inophyllum L. from the Calophyllaceae family. 3 kilograms of fresh bintangur leaves were processed into a simple drug to obtain 1 kilogram of dried simple drug. 500 grams of simple drug were macerated using 5 liters of 96% ethanol solvent. This resulted in 4 liters of macerated bintangur leaf simple drug.

The maceration results were concentrated using a Rotary Evaporator at a temperature of 60°C, which was carried out at the Integrated Research Laboratory of Prima Indonesia University, to produce a thick extract of 105.60 grams.

The yield obtained from bintangur leaves to obtain a thick extract is calculated as follows:

% Yield = 105.60/500 x 100%

Yield = 21.12%

After making a thick extract of bintangur leaves, formulate the sheet masks are made using several ingredients, such as hydrogenated PEG-40 castor Oil, Glycerin, Butylene Glycol, Sodium Polyacrylate, Ethanol 70%, Nipagin, Parfum, and Aquadest. Formula Sheet: The mask consists of four formulations, namely F0 (without extract), FI (0.5% ethanol extract of bintangur leaves), FII (1% ethanol extract of bintangur leaves), FIII (1.5% ethanol extract of

bintangur leaves). The results of light green and dark green preparations were obtained, and then physical evaluation and stability tests were carried out on the four preparations.

Figure 1. Sheet Preparation Mask Bintangur (Calophyllum inophyllum L.)

The results of organoleptic observations visually observed from *the sheet mask preparation* of bintangur leaf ethanol extract can be seen in Table 1.

Table 1. Organoleptic Test Results of Bintangur Leaf Ethanol Extract Sheet Mask

Formula	Organoleptic Observation		
	Color	**Form**	**Aroma**
F0	Colorless	thick liquid	Unscented + green tea
FI	Light green	thick liquid	Distinctive aroma of extract + green tea
FII	Dark green	thick liquid	Distinctive aroma of extract + green tea
FIII	Dark green	thick liquid	Distinctive aroma of extract + green tea

Information :
F0: Formula 0 without ethanol extract of bintangur leaves (Negative Control)
FI: Formula I with a concentration of 0.5% bintangur leaf ethanol extract
FII: Formula II with a concentration of 1% bintangur leaf ethanol extract
FIII: Formula III with a concentration of 1.5% bintangur leaf ethanol extract

The organoleptic test of the sheet mask preparation produced shows a thick liquid form and is light green in color in FI, dark green in FII and FIII. In addition, the sheet mask preparation of bintangur leaf ethanol extract has a distinctive aroma of the ethanol extract of bintangur leaves, added with the aroma of green tea leaves, which functions as a flavoring. In the stability test, the organoleptic test showed a change in the color of the FI, FII, and FIII preparations, namely a slightly brownish color due to the bintangur leaf ethanol extract, which is increasingly absorbed into the sheet mask.

A homogeneity test was conducted on the bintangur leaf ethanol extract *sheet mask preparation* to ensure that there were no coarse grains in the preparation that could cause inhomogeneity. Table 2 shows the results of the homogeneity test observations.

Table 2. Results of the Homogeneity Test of the Bintangur Leaf Ethanol Extract Sheet Mask

Formula	Homogeneity Testing
F0	Homogeneous
FI	Homogeneous
FII	Homogeneous
FIII	Homogeneous

Information :
F0: Formula 0 without ethanol extract of bintangur leaves (Negative Control)
FI: Formula I with a concentration of 0.5% bintangur leaf ethanol extract
FII: Formula II with a concentration of 1% bintangur leaf ethanol extract
FIII: Formula III with a concentration of 1.5% bintangur leaf ethanol extract

The pH test was conducted using a pH meter. The results of *the sheet mask preparation* containing ethanol extract of bintangur leaves are shown in Table 3.

Table 3. pH Test Results of Bintangur Leaf Ethanol Extract Sheet Mask

Formula	pH testing
F0	7.42
FI	7.08
FII	6.97
FIII	6.70

Information :
F0: Formula 0 without ethanol extract of bintangur leaves (Negative Control)
FI: Formula I with a concentration of 0.5% bintangur leaf ethanol extract
FII: Formula II with a concentration of 1% bintangur leaf ethanol extract
FIII: Formula III with a concentration of 1.5% bintangur leaf ethanol extract

The results of the viscosity test observations on *the sheet mask preparation* of bintangur leaf ethanol extract can be seen in Table 4.

Table 4. Viscosity Test Results of Bintangur Leaf Ethanol Extract Sheet Mask

Formula	Viscosity Observation			
	Test I	**Test II**	**Test III**	**Average**
F0	596.0 cP	556.0 cP	448.0 cP	533.33 cP
FI	636.0 cP	616.0 cP	612.0 cP	621.33 cP
FII	624.0 cP	608.0 cP	588.0 cP	606.66 cP
FIII	612.0 cP	604.0 cP	600.0 cP	605.33 cP

Information :
F0: Formula 0 without ethanol extract of bintangur leaves (Negative Control)
FI: Formula I with a concentration of 0.5% bintangur leaf ethanol extract
FII: Formula II with a concentration of 1% bintangur leaf ethanol extract
FIII: Formula III with a concentration of 1.5% bintangur leaf ethanol extract

This test was carried out to see whether *the sheet mask preparation* containing ethanol extract of bintangur leaves irritates the skin or not, and the results can be seen in Table 5.

Table 5. Results of Irritation Test of Bintangur Leaf Ethanol Extract Sheet Mask

Formula	Irritation Test Observation	
	Irritation	**No Irritation**
F0	-	✓
FI	-	✓
FII	-	✓
FIII	-	✓

F0: Formula 0 without ethanol extract of bintangur leaves (Negative Control)
FI: Formula I with a concentration of 0.5% bintangur leaf ethanol extract
FII: Formula II with a concentration of 1% bintangur leaf ethanol extract
FIII: Formula III with a concentration of 1.5% bintangur leaf ethanol extract

An irritation test conducted on 10 panelists found that all preparations were non-irritating. This is due to the formulation being well formulated.

Stability tests on *the sheet mask preparation* of bintangur leaf ethanol extract include organoleptic tests as shown in Table 1, homogeneity tests as shown in Table 2, and pH tests as shown in Table 3.

Table 6 Results of Organoleptic Stability Test of Bintangur Leaf Ethanol Extract Sheet Mask

Formula	Organoleptic Observation		
	Week 1		
	Color	**Form**	**Aroma**
F0	Colorless	thick liquid	Unscented + green tea
FI	Light green	thick liquid	Distinctive aroma of extract + green tea
FII	Dark green	thick liquid	Distinctive aroma of extract + green tea
FIII	Dark green	thick liquid	Distinctive aroma of extract + green tea

Formula	Week 2		
	Color	**Form**	**Aroma**
F0	Colorless	thick liquid	Unscented + green tea
FI	Brownish light green	thick liquid	Distinctive aroma of extract + green tea
FII	Dark brownish green	thick liquid	Distinctive aroma of extract + green tea
FIII	Dark brownish green	thick liquid	Distinctive aroma of extract + green tea

	Week 3		
Formula	**Color**	**Form**	**Aroma**
F0	Colorless	thick liquid	Unscented + green tea
FI	Brownish light green	thick liquid	Distinctive aroma of extract + green tea
FII	Dark brownish green	thick liquid	Distinctive aroma of extract + green tea
FIII	Dark brownish green	thick liquid	Distinctive aroma of extract + green tea

	Week 4		
Formula	**Color**	**Form**	**Aroma**
F0	Colorless	thick liquid	Unscented + green tea
FI	Brownish light green	thick liquid	Distinctive aroma of extract + green tea
FII	Dark brownish green	thick liquid	Distinctive aroma of extract + green tea
FIII	Dark brownish green	thick liquid	Distinctive aroma of extract + green tea

Information :

F0: Formula 0 without ethanol extract of bintangur leaves (Negative Control)
FI: Formula I with a concentration of 0.5% bintangur leaf ethanol extract
FII: Formula II with a concentration of 1% bintangur leaf ethanol extract
FIII: Formula III with a concentration of 1.5% bintangur leaf ethanol extract

Table 7. Results of the Homogeneity Stability Test of Bintangur Leaf Ethanol Extract Sheet Mask

Homogeneity Test Formula				
	Week 1	**Week 2**	**Week 3**	**Week 4**
F0	Homogeneous	Homogeneous	Homogeneous	Homogeneous
FI	Homogeneous	Homogeneous	Homogeneous	Homogeneous
FII	Homogeneous	Homogeneous	Homogeneous	Homogeneous
FIII	Homogeneous	Homogeneous	Homogeneous	Homogeneous

Information :
F0: Formula 0 without ethanol extract of bintangur leaves (Negative Control)
FI: Formula I with a concentration of 0.5% bintangur leaf ethanol extract
FII: Formula II with a concentration of 1% bintangur leaf ethanol extract
FIII: Formula III with a concentration of 1.5% bintangur leaf ethanol extract

Table 8. Results of pH Stability Test of Bintangur Leaf Ethanol Extract *Sheet Mask*

	pH Test Formula			
	Week 1	**Week 2**	**Week 3**	**Week 4**
F0	7.42	7.37	7.31	7.29
FI	7.08	7.07	7.06	7.05
FII	6.97	6.87	6.85	6.81
FIII	6.70	6.69	6.65	6.63

Information :
F0: Formula 0 without ethanol extract of bintangur leaves (Negative Control)
FI: Formula I with a concentration of 0.5% bintangur leaf ethanol extract
FII: Formula II with a concentration of 1% bintangur leaf ethanol extract
FIII: Formula III with a concentration of 1.5% bintangur leaf ethanol extract

CONCLUSIONS

Bintangur (Calophyllum inophyllum L.) leaf ethanol extract was successfully formulated into sheet masks at concentrations of 0.5%, 1.0%, and 1.5%, with acceptable physical characteristics and stability during four weeks of storage. Among the formulations, FI containing 0.5% Bintangur leaf extract demonstrated the most favorable overall physical quality and stability, maintaining homogeneity, acceptable viscosity, and the smallest change in pH during storage, with no observed irritation among the tested panelists. Therefore, FI is recommended as the most suitable formulation among those evaluated in this study. These findings support the potential further development of Bintangur as a locally sourced phytotherapeutic ingredient for cosmetic and preventive skin-care products; however, additional antioxidant efficacy, long-term stability, and safety evaluations are required before commercial application.

DISCUSSION

The incorporation of Bintangur (*Calophyllum inophyllum* L.) leaf ethanol extract into the sheet mask base produced homogeneous formulations at concentrations of 0.5–1.5%, indicating adequate physical compatibility between the extract and the formulation components. The viscosity values of all formulations were also within the reference range applied in this study, suggesting that the addition of the extract did not substantially compromise the consistency of the sheet mask essence. Similar findings have been reported for plant-based sheet masks, although the physicochemical characteristics may vary depending on extract concentration and the composition of the formulation base. For example, cassava leaf extract affected the organoleptic properties, pH, viscosity, and stability of sheet mask essence, while red spinach leaf extract formulated using 96% ethanol produced homogeneous preparations with acceptable pH and viscosity (Liska et al., 2022; Nurpermatasari et al., 2026).

The observed physicochemical changes during storage may be associated with the phytochemical characteristics of Bintangur leaves. *C. inophyllum* contains phenolic and flavonoid compounds with antioxidant properties, and ethanolic extracts have been reported to contain substantial total phenolic and flavonoid contents (Ruangsuriya et al., 2023). In the present study, extract-containing formulations gradually developed a brownish-green color from the second week of storage. This change may reflect oxidation or transformation of phenolic and flavonoid constituents or interactions between the extract and other components of the sheet mask matrix. However, because chemical degradation was not directly evaluated, this mechanism cannot be confirmed. Importantly, the formulations remained homogeneous without visible phase separation, indicating that the color alteration did not correspond to gross physical instability. Plant-derived sheet masks may show different stability patterns depending on their phytochemical composition and formulation system. For instance, kaffir lime peel sheet masks maintained their color and physical stability during cycling tests, whereas cassava leaf extract formulations showed changes in physicochemical characteristics during stability evaluation (Anggianingrum et al., 2024).

A gradual decrease in pH was observed during the four-week storage period. This change may be associated with chemical transformations of extract constituents or interactions between polar phytochemicals and the aqueous formulation base. The magnitude of pH change, however, was relatively small, particularly in FI, indicating reasonable short-term physicochemical stability. Comparable variations have been observed in other botanical sheet mask formulations. Red spinach leaf sheet masks prepared from 96% ethanol extracts showed pH values of approximately 5.18–5.64, whereas a biocellulose sheet mask containing *Morus*

alba root essence showed a pH of 6.45 with good homogeneity and physical stability (Saputri et al., 2023). These comparisons demonstrate that botanical extracts and formulation matrices can influence the final pH and viscosity of sheet mask preparations. Therefore, the changes observed in the Bintangur formulations should be interpreted as the combined effect of extract composition, concentration, and interactions with the formulation matrix rather than being attributed to a single phytochemical component.

The pH of the Bintangur extract formulations, ranging initially from 6.70 to 7.08, requires particular consideration for repeated facial application. The physiological surface of healthy skin is acidic, with the stratum corneum generally reported to have a pH of approximately 4.1–5.8, and this acidic environment contributes to epidermal barrier integrity, microbiome regulation, and skin homeostasis (Nurpermatasari et al., 2026). Maintenance of an acidic environment is also associated with enzymes involved in ceramide generation and normal skin barrier formation. Although no observable irritation occurred among the 10 panelists in the present study, the formulation pH was higher than the optimal physiological acidic range. Therefore, these findings should not be interpreted as evidence that a near-neutral formulation is optimal for the skin barrier. Further formulation optimization toward a mildly acidic pH closer to the physiological skin surface should be considered, while simultaneously evaluating whether pH adjustment affects extract stability, viscosity, and antioxidant activity.

Among the formulations, FI containing 0.5% Bintangur leaf extract demonstrated the most favorable overall physical stability, particularly because it maintained homogeneity and showed the smallest pH change during four weeks of storage. Nevertheless, the present study was limited to physicochemical evaluation, short-term stability, and preliminary irritation testing in 10 panelists. Antioxidant activity of the final formulation was not directly determined, and clinical outcomes such as skin hydration, transepidermal water loss, elasticity, or *in vivo* antioxidant effects were not evaluated. This limitation is important because incorporation of an antioxidant-rich extract into a sheet mask does not necessarily guarantee equivalent antioxidant activity in the final formulation. A recent study of avocado peel extract, for example, reported stronger antioxidant activity in the extract than in its formulated sheet mask, demonstrating the potential influence of the formulation process on biological activity (Khasanah et al., 2025). Future studies should therefore include standardized phytochemical characterization, direct antioxidant assays such as DPPH, ABTS, or FRAP, accelerated and long-term stability testing, and clinical evaluation of skin hydration and barrier function before the formulation is developed for broader preventive skin-care applications.

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